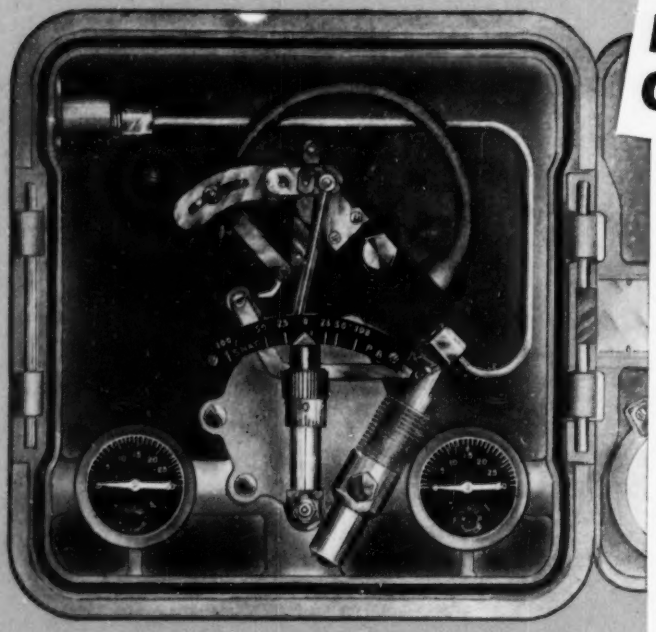
Instruments and AUTOMATION

Trade Mark Applied For

A small versatile wind tunnel for anemometer calibration. For story see page 1463. (*Photo courtesy Beckman & Whitley, Inc.*)

Vol. 27 No. 9
SEPTEMBER • 1954

Looking For The Finest Instrument-Type Pressure Control Pilot On The Market?



It's The New BS&B CLIMAX Type 1440!

Here's that new and better Instrument-Type Pressure Controller you've been waiting for—the BS&B CLIMAX Type 1440! Designed to handle both positive and negative pressures from high vacuum to any amount of pressure desired up to 10,000 lbs., Type 1440 is an instrument of highest sensitivity and utmost accuracy.

Bourdon Tube actuated—with all tubes, bellows assemblies, feed orifices and bleed nozzles calibrated—this unit has an output of 2.5 standard cubic feet per minute with a 17 lb. supply pressure. It will stroke a valve with 135 sq. in. diaphragm and 1½" of travel in 10.8 seconds for a pressure change of 3-15 lbs. on a supply pressure of only 17 lbs.!

Adaptable to vacuum relief control, reduced pressure control, fluid pressure control, pump discharge pressure control, boiler steam pressure control, off-and-on control, or snap action where each of the two limits may be set at desired points within 10% to 75% of the Bourdon Tube range. Bourdon Tube assemblies are available in bronze with ratings from 15 to 600 lbs., and in 4130 steel, 410 stainless steel or 316 stainless steel with ratings from 15 to 10,000 lbs. It's the only Pilot we know of that can be top valve mounted, yoke or spring case mounted, instrument board mounted or wall mounted.

OPERATIONAL FEATURES

Straight Line Proportional Action!

- √ Factory Calibration of Bourdon Tube, Proportional Bellows, Feed Orifice Nozzle and Proportional Snap Action Band Scale.
- √ Spring Loaded Bellows with Built-In Overtravel Protection.
- √ Flow Tested Feed Orifice Nozzle with Graduated Micrometer Set Point Adjustment.

Improved Sensitivity And Faster Controller Response Through The Power Relay Mechanism

- √ Double Diaphragm, Pressure Balanced.
- √ Molded Diaphragms.
- √ High Capacity Pilot Valve.
- √ Intermittent Bleed.

CONSTRUCTION FEATURES

- √ Weatherproof Case of Die Cast Aluminum Designed for Universal Mounting.
- √ Compact Size — 8" x 8" x 4".
- √ Two-Way Door Hinges to Left or Right, as Convenient.
- √ Straight Line Piping.
- √ Push Button Feed Orifice Cleaner.
- √ Pilot Action Reversible by Moving a Single Link, Without Tools.
- √ Snap Action or Proportional Band Settings Can be Made Without Tools.
- √ No Loose Linkages, Resulting in Easier Adjustment and Greater Sensitivity.
- √ Easy Parts Replacement or Assembly.

For complete information, contact your BS&B Representative . . . or write to . . .

BLACK, SIVALLS & BRYSON, INC.

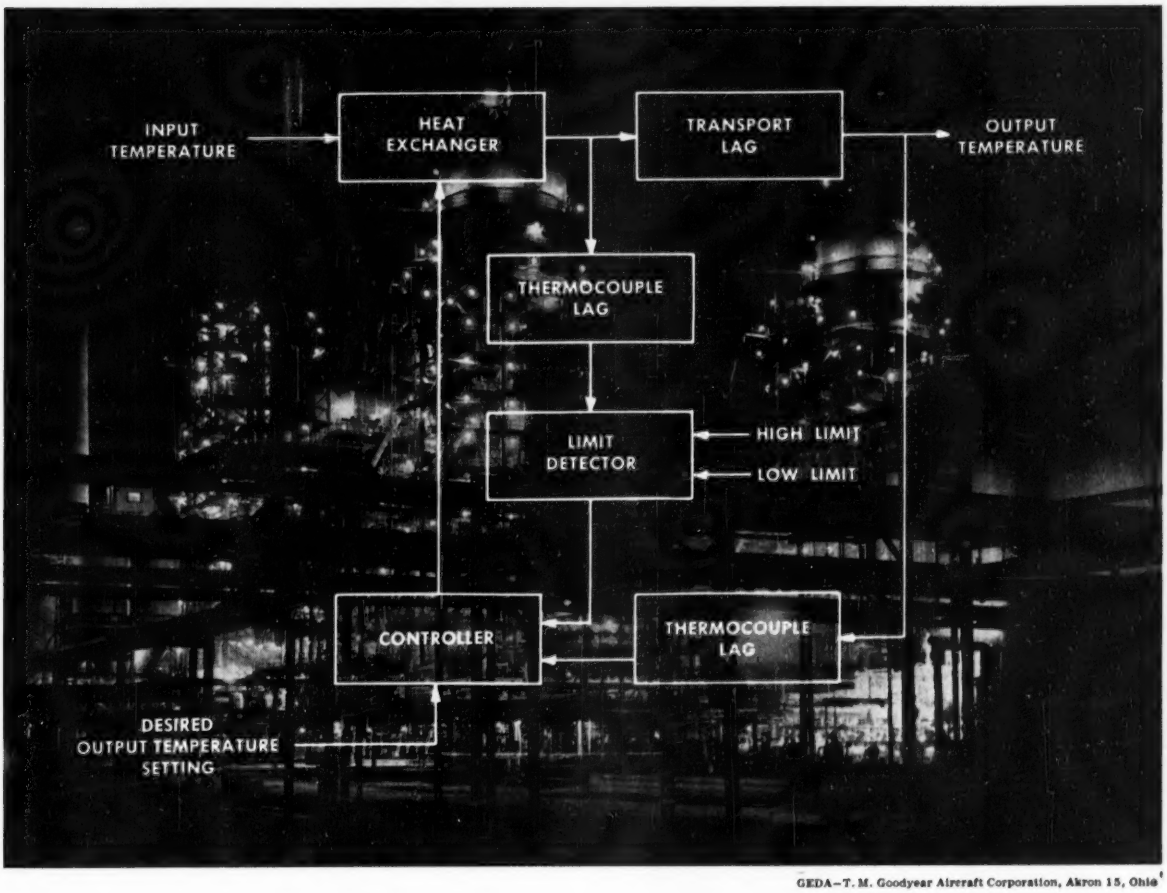
Climax Controls Division, Dept 4-V9

7500 East 12th Street — Kansas City 26, Missouri

EFFICIENCY OVER 60 YEARS BS&B RELIABILITY

For more information circle 1 on inquiry card.

GEDA SOLVES CONTROL PROBLEMS



GEDA—T. M. Goodyear Aircraft Corporation, Akron 15, Ohio

IS THE ABOVE SIMILAR to a control problem facing you right now? You can inject your own variables—it makes no difference. The point is:

GEDA—versatile analog computing equipment built by Goodyear Aircraft—*makes quick work of solving difficult control problems in EVERY type of industry.*

Development engineers need no longer use empirical methods or highly complicated equipment to wrestle with tough problems – even when they involve dynamic systems!

For GEDA is as easy-to-use as it is versatile –delivers the results in forms with which the engineer is already familiar–requires no learning of specialized mathematics.

A conversation with a GEDA representative will reveal many other advantages of this equipment – including the great versatility of its non-linear computer, leadership in stabilized electronic multiplier performance and the accuracy of GEDA plug-in units. Why not let him show you how GEDA equipment can best be applied to serve you?

WRITE for GEDA catalog and complete information. Address: Goodyear Aircraft Corporation, Dept. 931EU, Akron 15, Ohio.

SEE GEDA EXHIBIT
at the
1st International Instrument
Congress & Exposition
—PHILADELPHIA—
September 14th through 24th

save time with **GEDA.**

GOODYEAR AIRCRAFT

For more information circle **2** on inquiry card.

One Source of Supply—
for all **METAL PRODUCTS!**

FALSTROM

INSTRUMENT PANELS
CONTROL BOARDS
TRANSMITTER CABINETS
CONSOLES-POWER FRAMES
CUSTOM ASSEMBLIES

COMPLETE SERVICE FROM DESIGN . . .

. . . TO ASSEMBLY

FALSTROM has the experience and the facilities to produce your metal products from detailed specifications or design assemblies to meet your requirements.

FALSTROM standard designs can save you time and money. For recommendations and estimates, call or write FALSTROM, today!

VISIT BOOTHS 651-653
1st INTL. INSTRUMENT CONGRESS
Commercial Museum, Philadelphia, Pa.
Sept. 15-21

ASK FOR NEW FALSTROM **BULLETIN NO. 142**
Contains complete information on FALSTROM metal products. Call or write for your copy, today!

Telephone: PRescott 7-0013
FALSTROM COMPANY
92 FALSTROM COURT
PASSAIC, NEW JERSEY

QUALITY METAL PRODUCTS FOR INDUSTRY SINCE 1870

For more information circle **3** on inquiry card.

EPLAB

PYRHELIOMETER
For the Measurement of SOLAR RADIATION

Eppley Pyrheliometers are used for solar radiation measurements at ninety-eight weather stations in the continental United States, Canada, Alaska, Greenland, Iceland, Caribbean Sea, and the Pacific Ocean. Sixty-two of these stations are under the direction of the United States Weather Bureau.

The Eppley Pyrheliometer was adopted as standard equipment by the Weather Bureau after considerable experimentation. It was found to be the best instrument so far tested by the Bureau.

Used in conjunction with a suitable recorder, the Eppley Pyrheliometer will provide an accurate and reliable record of total solar and sky radiation on a horizontal surface.

Bulletin No. 2 on Request

THE EPPLEY LABORATORY, INC.

Scientific Instruments

2 Sheffield Ave.
Newport, Rhode Island U.S.A.

For more information circle **4** on inquiry card.

Contents...

Vol. 27, No. 9, September 1954

Instruments and AUTOMATION

Richard Rimbach, Publisher
Manoel F. Behar, Editor
Milton H. Aronson, Technical Editor
James Emge, Associate Editor
David S. Aland, Associate Editor
Milo D. Pugh, Western Editor
Armand Gaudreau, Consulting Editor (Automation)

District Offices and Managers

Altadena, Calif., Milo D. Pugh & Associates: M. D. Pugh, 2721 N. Marengo Ave., SYcamore 7-2894; Hunter Vinton, 1050 Lincoln Ave., Palo Alto, Calif., DA 5-4815.

Boston 16, Mass. Harold H. Short, Jr., Room 312, 419 Boylston St., Kenmore 6-3990

Chicago 1, Ill. Harold W. Haskett, 1205, 228 N. La Salle St., Central 6-8963

Cincinnati 5, Ohio. Harold W. Haskett, 742 Elberon Ave., Grandview 4323

Dallas, Texas, Edward F. Wright (Oklahoma-Texas-Louisiana) 505 N. Ervay, Rm. 310. Prospect 0189

New York 17, N. Y. Richard Rimbach, Jr., 525 Lexington Ave., Rm. 359, Murray Hill 2-0821

Philadelphia, Pa. Robert H. Maxwell, 7 Wilde Ave., Drexel Hill, Pa., Clearbrook 9-4342 (Phila. Suburban).

Pittsburgh 12, Pa. C. Goldcamp, 815 Ridge Ave., Fairfax 1-0161

St. Louis 1, Mo., James R. Wright (Missouri, Southern Illinois, Southern Indiana), Stephen E. Wright (Iowa, Nebraska, Kansas), 706 Chestnut St., Chestnut 1-1965

London. W.1, England. John C. N. Hughes, Crown House, 143-147 Regent St., Regent 3891

MEMBER

ABC

Audit Bureau of Circulation.

SUBSCRIPTION RATES
For One and Two Years.

United States, U. S. Possessions, and Canada $4.00, $7.00 (2 yrs.).

Latin America and Australia $5.00, $8.00 (2 yrs.).

All other countries except those noted below $6.00, $10.00 (2 yrs.).

For the present, subscriptions not accepted from Austria, Bulgaria, China, Czechoslovakia, Eastern Zone Germany, Hungary, India, Poland, Romania, Russia and Yugoslavia.

Payments from outside the U. S. A. must be in the form of an International Money Order or check on a U. S. Bank.

Position and company connection as well as products manufactured must be indicated in all subscription orders.

Feature Articles

• Survey of Integrated Data-Conversion Systems 1460
by F. K. Williams and M. L. Klein

• Calibration Wind Tunnel 1463
by Robert C. Nyden

• New Design Trends for Electrically-Operated Valves 1464
by A. Brothman and S. Lidz

• Importance of Edge Sharpness on Small Orifice Meters 1468
by G. C. Huffman, L. W. Thrasher, and R. C. Binder

• Water Treatment Requires Centralized Instrumentation ... 1470
by R. S. Darke

• NBS Research in Radio Propagation 1472

• Machine-tool Load Indicators 1474
by D. C. Russ, Jr.

• Adapting Present Machine Tools for Automatic Operation .. 1479
by Julius Y. Kaplan

New Serial

• The Automatic Factory—A Critical Examination 1476
by Stephen A. June, John D. Bardis, Lee H. Lurio, Leonard S. Polaner, Oystein Sagedahl, Herbert A. Sklenar and Bernard K. Yenkin

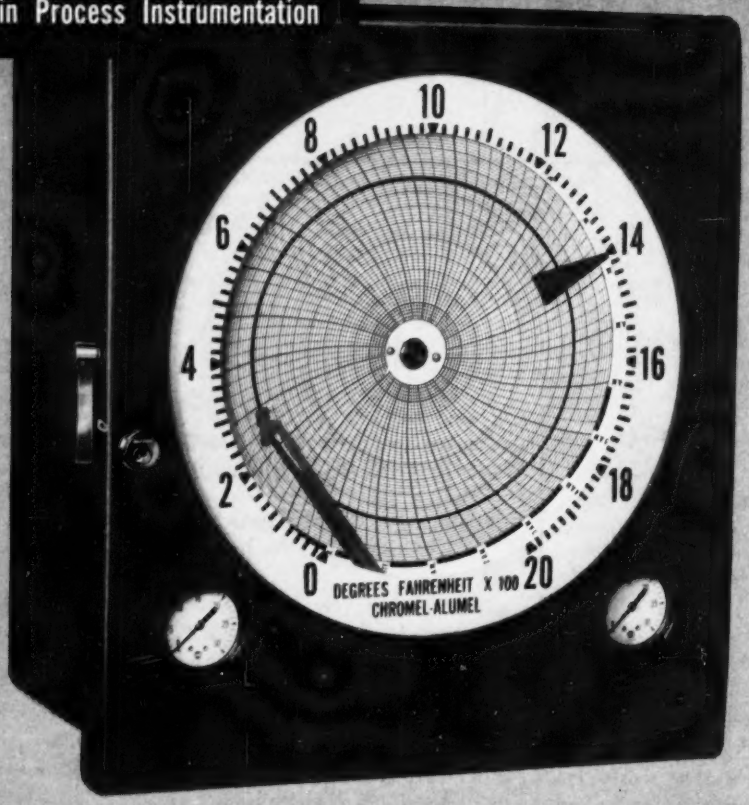
Journal of the Southern California Meter Association

• Variable-Area Flowmeters 1482
by D. V. Gayton

Other Regular Features

• Trends 1359
• On the March 1364
• Books 1372
• Editorial 1399
• New Instruments 1400
• Events Calendar 1485
• Briefs 1486
• New Literature 1494
• Searchlite Section 1506
• Advertisers' Index 1508
• Inquiry Card 1509

Copyright 1954, published monthly, by The Instruments Publishing Company, Inc. Office of publication, 1600 North Main Street, Pontiac, Illinois. Executive and Editorial Office, 845 Ridge Avenue, Pittsburgh 12, Pennsylvania. Entered as second class matter, October 14, 1949, at the post office at Pontiac, Illinois, under the act of March 3, 1879.



LONG TERM ACCURACY and precision of measurement are assured with the new G-E potentiometric recording system. It is designed for continuous control, even at 0 F ambient temperatures. The "floating" pointer gives you increased chart visibility; makes chart changing simple and helps to reduce servicing time to a minimum. See this and other G-E instruments at the Instrument Society of America Show, Sept. 15-21, Commercial Museum, Philadelphia, booths 531-537.

USE G-E PYROMETERS FOR ACCURATE CONTROL

General Electric Pyrometers Give Dependable Protection

TYPE HP-3 PYROMETER, a two-position controller, has positive control action, initiated by 0.1 percent in full-scale movement of instrument pointer. This gives accurate readings from easy-to-read 7-inch scale. Units are available for flush or surface mounting. Indicator, controller, and protector units are plug-in type, permitting easy servicing.

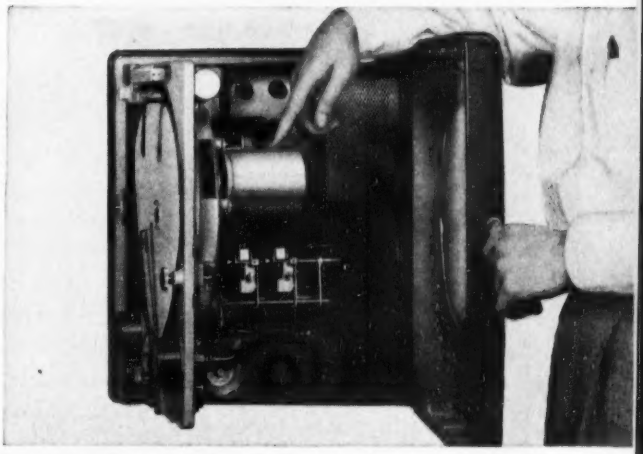
Newly Designed G-E Recording Controller Eliminates Many Troublesome Components

Provides Truly Continuous Standardization

General Electric's new d-c recording controller assures you of having less maintenance by eliminating conventionally used dry cells, standard cells, slidewire and sliding contacts. Replacement costs for dry cells, or worn, corroded electrical contacts are gone, and servicing time is reduced at no extra cost.

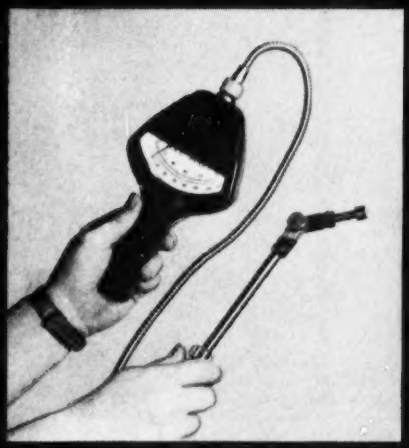
THE MAGNETIC STANDARD provides truly continuous standardization through the revolutionary measurement-circuit design, which incorporates the high stability of a permanent magnet for a reference standard. Loss of measurement and control during standardization periods can never be experienced with the constantly balancing G-E system.

NEW RECORDING CONTROLLER offers such features as: long term accuracy and precision of measurement; continuous, dependable control; increased chart visibility; simplified chart changing; and better protection of processes against damage due to component failure. These features mean more cost and time savings in your process operations.



COMPACT CONSTRUCTION assures servicing ease for minimum of maintenance required. The controller has a maximum number of plug-in-parts to facilitate range changing in the field. No unsoldering is required.

G-E HAND PYROMETER DESIGNED FOR WIDE USE



GENERAL ELECTRIC COMPANY
SECTION A 602-277
SCHENECTADY 5, NEW YORK

Please send me a copy of the bulletins checked below:

- ☐ GEA-6020 Hand Pyrometer
- ☐ GEC-714 Thermocouples and Accessories
- ☐ GED-2100 New Recording Controller

Name .....

Company .....

Street .....

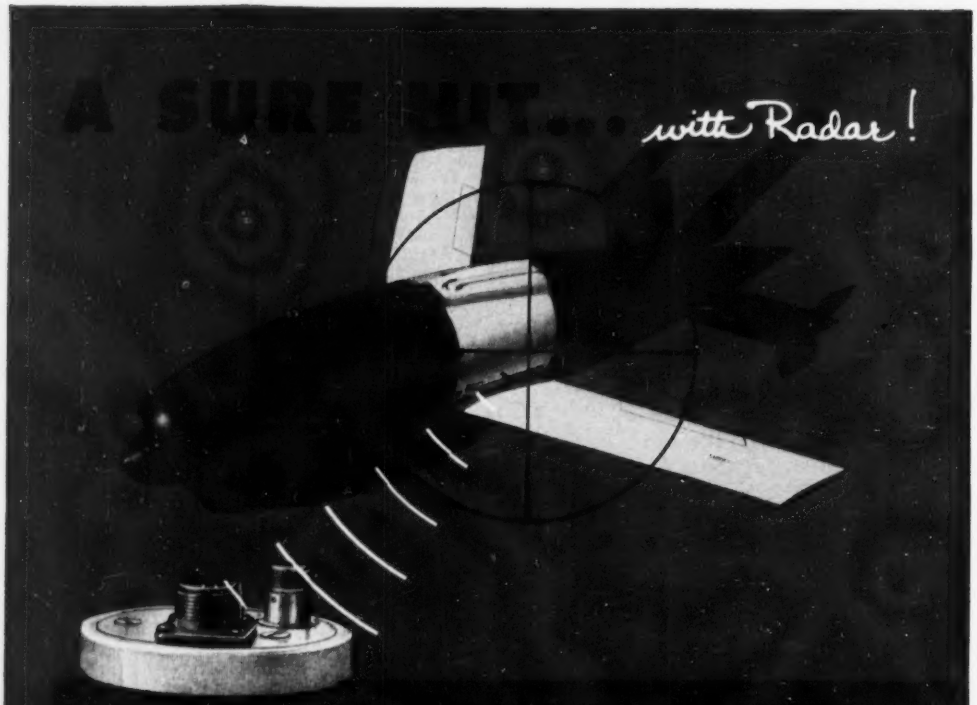
City ..... Zone ..... State .....

DUAL-RANGE General Electric hand pyrometer is designed for flexible and inexpensive measurement of gas, surface and molten-metal temperatures.

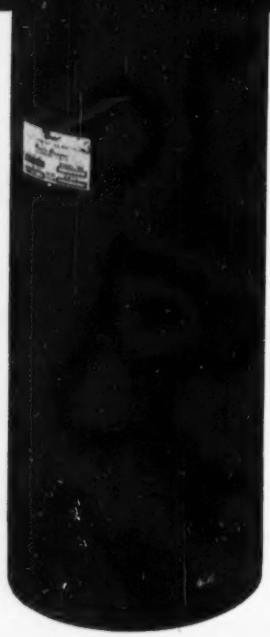
EASY-TO-USE hand pyrometer accurately indicates temperature of precision castings. Instrument is lightweight with non-slip, bayonet-grip handle.

GENERAL ELECTRIC

For more information circle **5** on inquiry card.



NEW RYAN FIREBEE JET TARGET PLANE
IS EQUIPPED WITH BENDIX-PACIFIC RADAR
BEACON FOR EASY IDENTIFICATION



The high performance and small size of the Ryan Firebee makes it difficult to track in a radar scope. For this reason the Firebee is being equipped with the Bendix-Pacific Radar Beacon. This equipment provides a reinforced echo which materially extends the radar range and produces a powerful signal that is easily observed. In effect, the Beacon increases the size of the Firebee to that of larger aircraft.

In addition to use in target planes, Bendix-Pacific Beacons can simplify air traffic control problems, reduce the time of locating aircraft for radar checkouts and increase the possibility of locating and identifying aircraft and other objects in distress.

Both "X" and "S" band Beacons are readily available. Write for complete information.

SPECIFICATIONS

	S-Band	X-Band
Power Output: watts peak	100	15
Receiver Sensitivity: dbm	−42	−42
Tuning Range: mc.	2700-3000	8500-9600
Interrogation Rate: pps.	200-5500	400-5500

Acceleration Conditions: 55 G longitudinally for 5 seconds.
Vibration Conditions: .06 inches total amplitude at 55 cps for 3 min.
Shock Conditions: 30 G in any plane for 11 milliseconds.
Altitude: The beacon is pressurized for very high altitude operation.
Temperature Test: 5 min. satisfactory operation at 300°F ambient.
Size: 3.5 in. diameter by 12.25 inches long.
Weight: 6.1 pounds.

RADAR

SONAR

HYDRAULICS

TELEMETERING

ELECTRO-MECHANICAL

ULTRASONICS

BENDIX PACIFIC

THE NAME Bendix AVIATION CORPORATION MEANS MORE

PACIFIC DIVISION • Bendix Aviation Corporation
11600 Sherman Way, North Hollywood, California

East Coast Office: 475 5th Ave., N.Y. 17
Export Division: Bendix International 205 E. 42nd St., N.Y. 17
Canadian Distributors: Aviation Electric, Ltd., Montreal 9

For more information circle **6** on inquiry card.

WHAT'S NEW AT BRISTOL...

SIMPLICITY? Look inside!

Remove the cover from the new Bristol Metagraphic pneumatic transmitter. You see at once the inherent simplicity of Bristol's world-famous measuring element.

These Bristol measuring elements have chalked up as much as 35 years' continuous service without attention.

The Metagraphic transmitter sets new standards of accuracy and reliability in measuring and transmitting readings of temperature, pressure, vacuum, differential pressure and liquid level. Here are some of its features:

NON-BLEED BOOSTER PILOT for low air consumption. In balanced position, air consumption is only 0.07 scfm.

HIGH-SPEED TRANSMISSION and superior control result from large air capacity of the pneumatic relay – 3.0 scfm.

INDICATING DIAL GAUGE to show output pressure can be screwed into front of transmitter. No piping or fittings are needed.

Get the whole story on the Metagraphic transmitters. Write for free bulletin A105 to The Bristol Company, 113 Bristol Road, Waterbury 20, Connecticut.

FRICTIONLESS METAGRAPHIC TRANSMITTER has only one pivot, no flexures. It's sensitive to extremely small changes in the measured quantity (as minute as 0.03% of range, including reversal). You can get the Metagraphic in a wide selection of ranges, with magnified ranges available and overrange protection standard.

4.24

BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **7** on inquiry card.

NOW...

THE 6000# HANCOCK STAINLESS STEEL

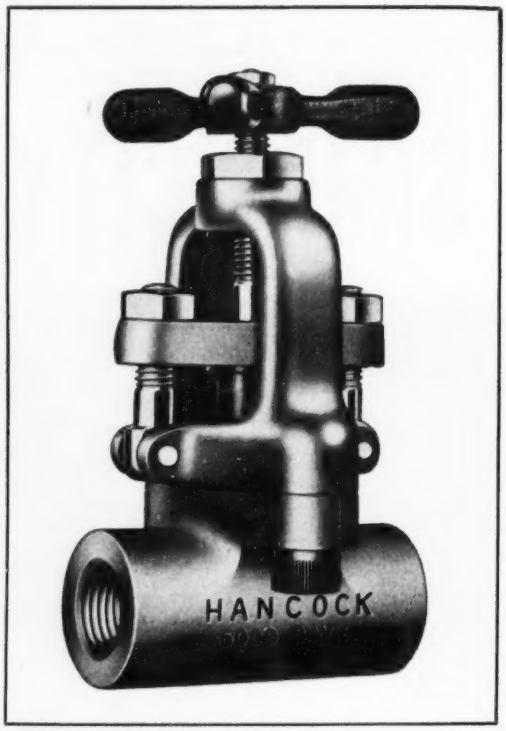
INSTRUMENT VALVE

A new HIGH PRESSURE valve for use on

INSTRUMENT PANELS
INSTRUMENT LINES
GAUGE LINES
BY-PASS LINES
CORROSIVE LINES
ORIFICE METERS

This heavy-duty Hancock Instrument Valve was specially engineered for these and similar services where high temperatures are of short duration and occur infrequently. It is small, easy to handle—weighs only 2¼ lbs. Space-saving compactness permits close alignment of piping with near structures. The packing gland can be readily pulled tight in close quarters. Disassembly is no problem in tight spots. Every practical use of stainless steel assures maximum protection against corrosion. You can be sure of long-life service and economical maintenance.

YOUR INDUSTRIAL SUPPLY DISTRIBUTOR has the 6000# Hancock Instrument Valve. He is as close as your telephone. Call him for complete specification and operational data. You can count on fast delivery to meet your requirements.



SPECIFICATION DATA

SERVICE RATING: 6000# O.W.G.—100° F.
TYPES: Globe and angle.
SIZES: ¼", ⅜" and ½".
CONNECTIONS: Screwed and socket weld ends.
BODY: Type 410 forged stainless steel with integral stuffing box.
YOKE: Forged carbon steel—bolted to body with two hollow head alloy steel cap screws removable with Allen-type wrench. **No bonnet joint**—no gasket to leak or blow.
STEM: 300 Brinell stainless steel with bronze stem thread bushing.
STEM-DISC: Needle point design.
SEAT: Type 410 stainless steel. Integral with the body.
PACKING GLAND: Forged steel. Packing gland bolts, nuts, pins and packing stop rings—stainless steel.
PACKING: Highest quality long fiber asbestos, graphited and corrosion inhibited.
HANDLE: Malleable iron. Three-prong type for easy operation. Handle nut—steel.
MARKER PLATE: Stainless steel.

1877 HANCOCK U.S.A.

When Hancocks go in, valve costs go down

HANCOCK VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** Watertown 72, Massachusetts

MAKERS OF 'HANCOCK' VALVES, 'ASHCROFT' GAUGES, 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, AIRCRAFT PRODUCTS. BUILDERS OF "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

For more information circle 8 on inquiry card.

NOW...

reduce process control costs, increase product uniformity and output . . . fewer system components, lower initial cost, lower inventory investment, lower installation and maintenance costs

(actual size)

ATCOTROL

a reset timer for your machine and process control systems which establishes a new order of performance standards

Here is news for every control engineer! New and exclusive features never before available in timers.

Five important process operations are checked just by looking at the dial. Millisecond reset without pointer bounce. One-tooth infinite-position clutch. One timer body for 10 standard ranges and either reset or stop on power failure; changes easily and quickly made. 148 circuit arrangements. Wipe-action over-sized load contacts. *Repeat accuracy of 1/10 of 1%.* Exceeds NEMA standards.

Only one notched clearance hole for installation. No lubrication ever required. Completely serviced with only a screwdriver and set-screw wrench.

Get the full story on ATCOTROL by (1) catalog, (2) 20-minute operating demonstration at your desk, (3) trial unit for original equipment manufacturers. Write today to Automatic Temperature Control Company, 5224 Pulaski Avenue, Philadelphia 44, Pa. Represented in Canada by: Powerlite Devices, Ltd., Toronto, Montreal and Vancouver.

atc®

RESET TIMERS

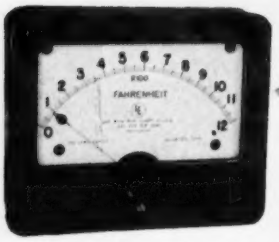
For more information circle 9 on inquiry card.

LEWIS

AUTOMOTIVE AND INDUSTRIAL TEMPERATURE MEASURING EQUIPMENT

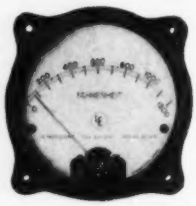
Sturdy Dependable Indicators —Suitable For Use In Moving Vehicles or For Permanent Installation

This instrument has been used extensively by the leading motor-car manufacturers for road testing on the "Proving Grounds" — where performance counts. Housed in a rectangular bakelite case, this reliable, fully compensated pyrometer is furnished with 6 in. hand drawn scales for greater accuracy. The Model 58PY is available for use with all standard thermocouple materials, in many ranges to suit the most exacting application.



MODEL 58PY

Manufactured with the same type of movement as our aircraft pyrometers, the Model 23B pyrometer is well suited for use in moving vehicles and has been successfully used in many marine diesel installations for measuring exhaust temperatures. It is housed in a 4 in. round bakelite case that is flanged for panel mounting, and is available in several ranges for use with various thermocouple materials.



MODEL 23B

The Model 20B series of indicators are patterned after our standard aircraft instruments and are supplied with 3" round steel cases suitable for panel installation. These compact, sturdy indicators have 2⅛ in. scales, are fully cold-end compensated and are available in many ranges for use with various thermocouple materials.

MODEL 20B

The Model 62RT4F resistance thermometer is a sturdy easy-to-read instrument with a 6 in. hand drawn scale. It is suitable for use in moving vehicles and is excellent for flight-test work. It is operated by an ordinary dry cell and is calibrated to standard "AN" bulb curves for various ranges in fahrenheit or centigrade.

MODEL 62RT4

THERMOCOUPLES for use with the above indicators are available in many styles for special applications. We have developed a complete line of aircraft, industrial and automotive thermocouples and would be pleased to offer our recommendation for your application.

THERMOCOUPLE LEAD WIRE for connecting thermocouples to the indicators is manufactured in iron-constantan, copper-constantan or chromel-alumel material with standard and special insulation. Use Lewis lead-wire with Lewis instruments and thermocouples for best results.

RESISTANCE BULBS for use as sensing elements for the 62RT4 thermometers are available in several types for various applications, for measuring free air or liquid temperatures. We invite inquiries on your application.

THE LEWIS ENGINEERING CO.

Specialists in Electrical Temperature Measurements

NAUGATUCK, CONNECTICUT

For more information circle **10** on inquiry card.

Trends...

Instruments and AUTOMATION

Medical instrumentation is beginning to attract attention of practitioners as well as medical laboratory and diagnostic workers, and is coming into general clinical use. New equipment includes intense-image X-ray fluoroscope equipment, ultrasonic locator for tumors and other foreign bodies, miniature TV pickup tubes for use inside body, color TV for training in surgery, electrocardiographs for analysis of heart beats, electroencephalographs for analysis of brain waves, magnetic-tape equipment for use with muscle-condition analyzers, mechanical-electronic hearts and lungs, ultraviolet-light microscopes.

RF (radio-frequency) instrumentation is expanding. FCC has authorized more than 16,000 miles of microwave communication systems. More than half the total mileage is operated by oil and gas pipeline companies. New uses include remote control in nuclear experiments and new radio sextant that determines sun position via reception of microwave energy.

Capital investment in atomic-energy plant facilities is estimated by AEC to have reached $5.7 billions. Interest among industrial firms in development of nuclear power is mounting; number of industrial teams surveying reactor design and technology is now 13 (increase of 5 in 6 months). The five new study groups are Babcock & Wilcox, American Mach. & Foundry, Bendix Aviation, Westinghouse Electric, and Pac. Northwest Power. First book on small research reactors has been published.

Automation of existing machine tools is bigger market than completely new "automatic factories." More than 75% of all machine tools are less than 20 years old; more than 75% of all machined products are still in "small lot" category.

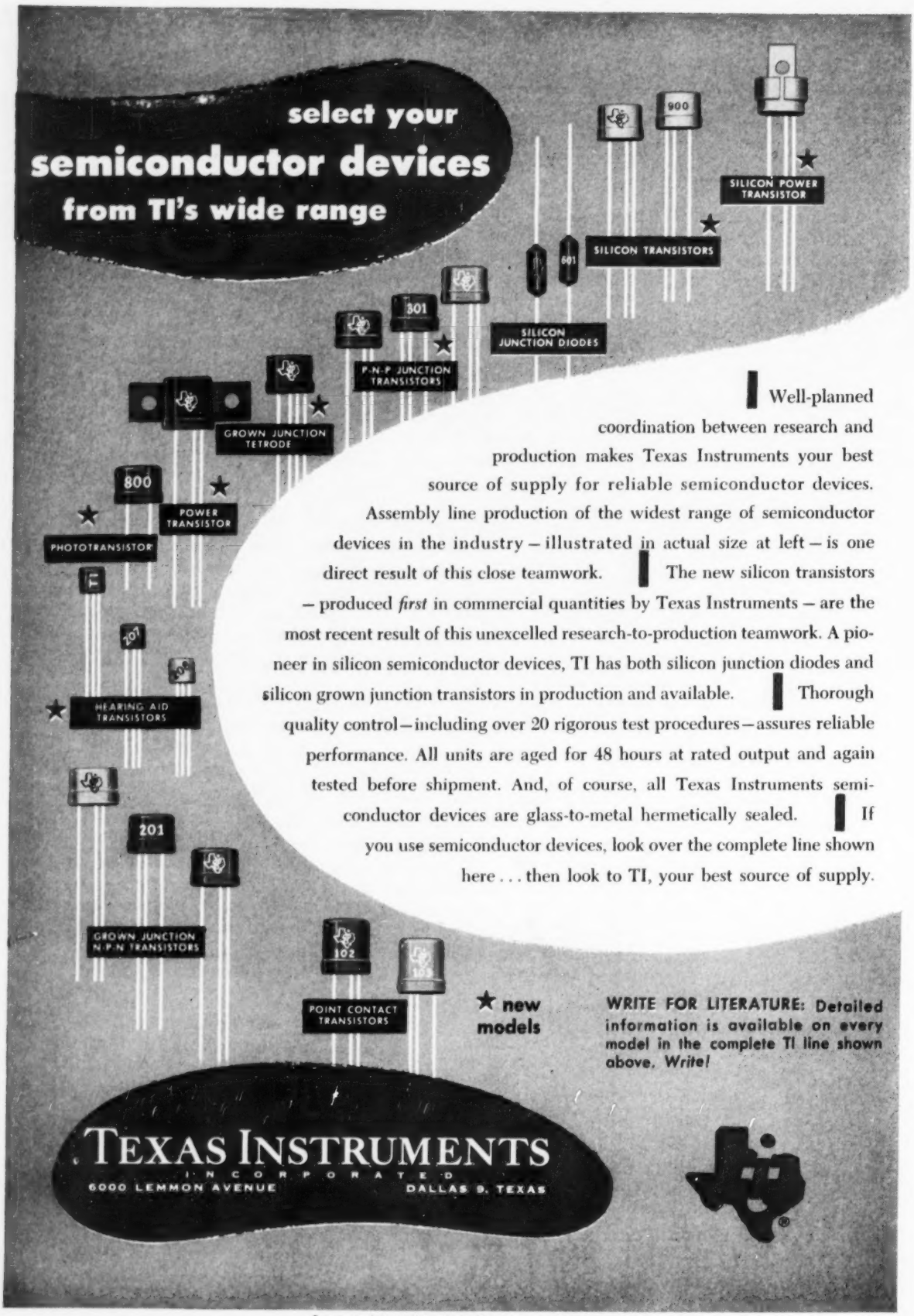
Will automation displace labor and cause unemployment? In recent address, D. S. Harder, Ford Motor Co. (originator of the word) said:" . . . the same things must have been said about mass production, the invention of the sewing machine, the steam engine . . . and all other advances in manufacturing. . . . In my opinion, automation will do just the opposite. It will create more jobs, create more products at less cost, and increase the ability of people to consume. . . . Automation will enable us to meet the needs of our expanding population, will increase our standard of living."

Cathode-ray-tube indicators now appear on process-control centralized panels. New Kybernetes electronic scanner uses CR-tube indicator.

Use of computers is only new thing in "new" field of automation, says recent Harvard report. First computer clinic offers opportunity to see various types in demonstrations (see page 1399).

Office copying equipment is new and expanding field. Conventional diazo and photographic techniques are meeting competition from newer diffusion-transfer types and heat-sensitive types. Photoelectric type is in development.

Twenty billion dollars will be spent on continental defense within three years, says Major A. P. deSeversky at recent symposium on "Electronics in Air Power."



Well-planned coordination between research and production makes Texas Instruments your best source of supply for reliable semiconductor devices. Assembly line production of the widest range of semiconductor devices in the industry – illustrated in actual size at left – is one direct result of this close teamwork. The new silicon transistors – produced *first* in commercial quantities by Texas Instruments – are the most recent result of this unexcelled research-to-production teamwork. A pioneer in silicon semiconductor devices, TI has both silicon junction diodes and silicon grown junction transistors in production and available. Thorough quality control – including over 20 rigorous test procedures – assures reliable performance. All units are aged for 48 hours at rated output and again tested before shipment. And, of course, all Texas Instruments semiconductor devices are glass-to-metal hermetically sealed. If you use semiconductor devices, look over the complete line shown here . . . then look to TI, your best source of supply.

For more information circle **11** on inquiry card.

magneto manufacturers find

CRUCIBLE PERMANENT MAGNETS

provide maximum energy... minimum size

The *consistently higher* energy product of Crucible Alnico permanent magnets enables manufacturers to use smaller, more powerful magnets in the magnetos of outboard motors, power mowers and other gasoline-powered equipment.

In fact, ever since Alnico alloys were first developed, Crucible has been supplying them to manufacturers of permanent magnet magnetos, generators and motors and all types of magnet-equipped devices.

Pioneers in magnet design and production, Crucible's magnet division is backed by a half-century of fine special steelmaking. So when you have a magnet application it will pay you to *call Crucible.*

CRUCIBLE first name in special purpose steels

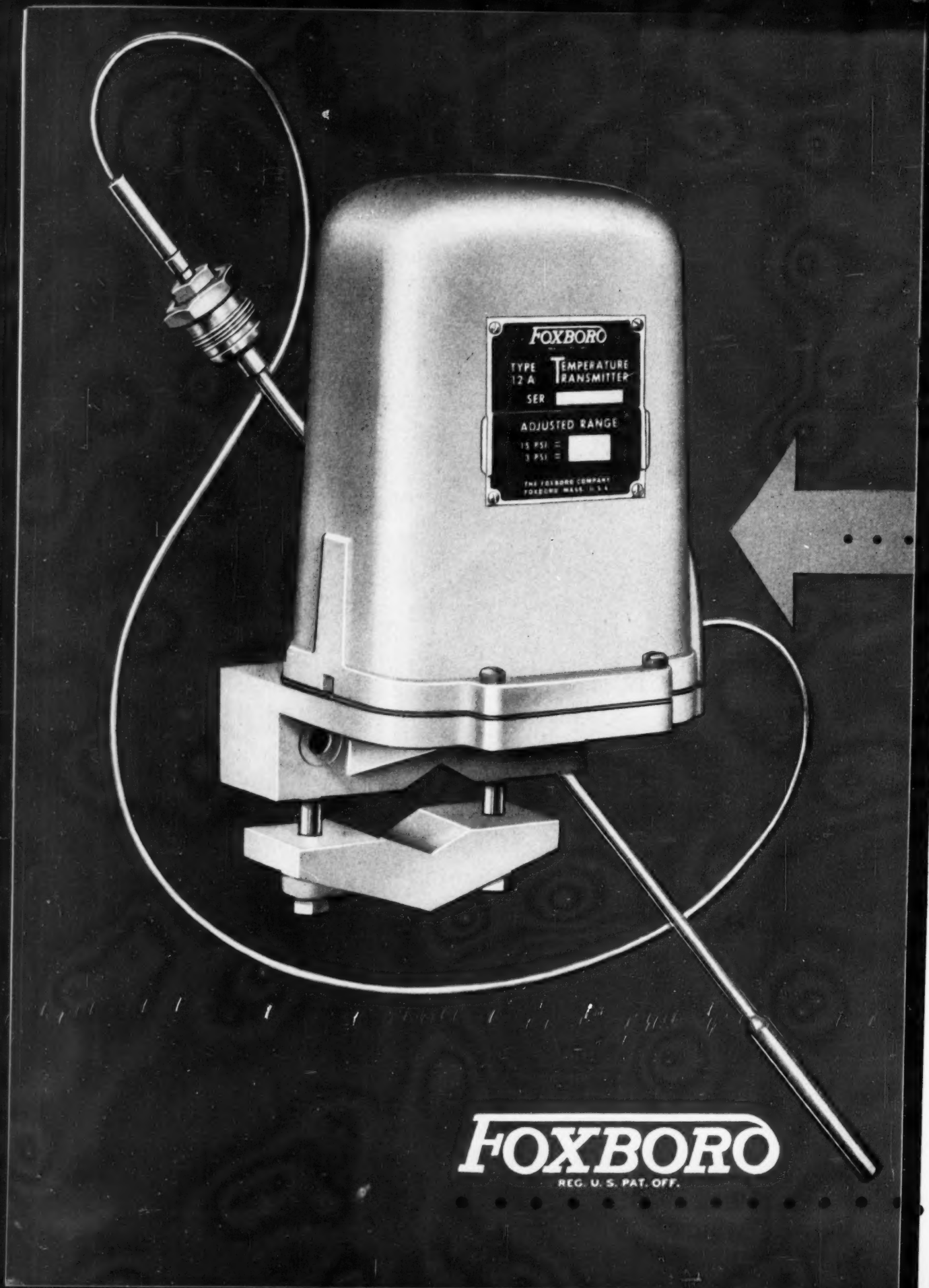
54 years of Fine steelmaking **ALNICO PERMANENT MAGNETS**

CRUCIBLE STEEL COMPANY OF AMERICA, GENERAL SALES OFFICES, OLIVER BUILDING, PITTSBURGH, PA.

STAINLESS • REX HIGH SPEED • TOOL • ALLOY • MACHINERY • SPECIAL PURPOSE STEELS

Canadian Distributor — Railway & Power Engineering Corp., Ltd.

For more information circle **12** on inquiry card.


FOXBORO
TYPE 12 A TEMPERATURE TRANSMITTER
SER
ADJUSTED RANGE
15 PSI =
3 PSI =
THE FOXBORO COMPANY
FOXBORO MASS. U.S.A.
FOXBORO
REG. U. S. PAT. OFF.

Rugged, Versatile Temperature Transmitter Improves Remote Control

. the Foxboro M/12A (pneumatic)

There is no easier, simpler way to measure remote temperatures, *fast*, over so wide a range, with such high sustained accuracy, and at so low a cost!

Between the limits of —100°F. and +1000°F., with operational spans of 50°, 100°, 200°, and 400°F, this rugged, highly responsive instrument performs outstandingly under the most severe conditions. It is fully compensated for ambient temperatures and pressure, and is insensitive to mechanical vibration.

Derivative action can be furnished for optimum performance when substantial thermal or transmission lags exist.

With its weatherproof housing and integral mounting bracket, it can be installed in any hazardous, corrosive, or outdoor location. Transmission lines are ¼" O.D. tubing — no troublesome conduit, no costly capillary to run.

Write for Bulletin 13-17. It explains fully why the Foxboro M/12A Temperature Transmitter gives better performance with lower installation and maintenance cost. **The Foxboro Company, 469 Neponset Ave., Foxboro, Mass., U.S.A.**

FACTORIES IN THE UNITED STATES, CANADA AND ENGLAND

• Pneumatic Temperature Transmission

For more information circle **13** on inquiry card.

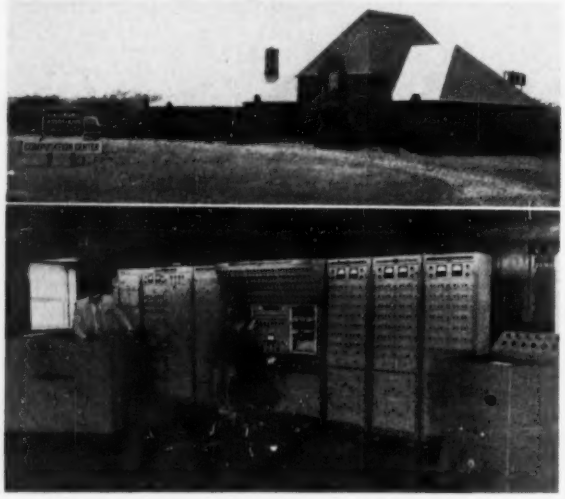
INSTRUMENTS ON THE MARCH

New Principles, Applications, Non-commercial Developments

Computer Center in N. Y.

PRINCETON, N. J.—An analog computation center was opened July 14th on U. S. Route 1, near Princeton, New Jersey, by Electronic Associates, Inc. to meet the demand for a headquarters where members of industry can solve their problems in Management Operations Control, Dynamic Systems Analysis, Applications Engineering, and Simulation. The center will provide a staff of scientists available for problem analysis as well as equipment which may be rented on an hourly, weekly, or monthly basis for problem solution.

This analog computation equipment may be used for the rapid and economical analysis and solution of complex problems in engineering research, design, and distribution;



and for the simulation of physical laws and continually varying complex quantities.

Specific application problems are to be found in the fields of aircraft engineering, mechanical and automotive engineering, electrical engineering, management operational control, chemical process control, geophysics, pipeline systems, etc.

The Director of the Electronic Associates Computation Center is Mr. R. R. Favreau. The equipment at the Computation Center includes a dual control console, 96 operational amplifiers, 15 servo multipliers, 4 servo resolvers, 5 servo-type function generators, a two-channel X-Y recorder, and a 6-channel curvilinear recorder. A quantity of pre-patch panels makes it possible to program problems in advance of the time they are actually placed in the computer.

Electronic Computer Clinic

PITTSBURGH, PA.—Announcement is made of the First Electronic Computer Clinic, to be held in conjunction with the First International Automation Exposition, at the 244th Regiment Armory, 14th Street between 6th and 7th Avenues, New York, N. Y., November 30 to December 2. (The EXPOSITION dates are November 29-December 2).

The clinic is a lecture and demonstration course on electronic computers, digital and analog, and will offer for the first time, demonstrations and typical applications of different types of computers. The wide general interest in applications of electronic computers assures that this clinic will be of great importance in opening up the application possibilities of electronic computers within the vast field of automation.

Attendance at the sessions will be restricted in size. Sessions will be repeated up to a maximum of 9 times to accommodate registrants. The registration fee is $5.00, payable in advance.

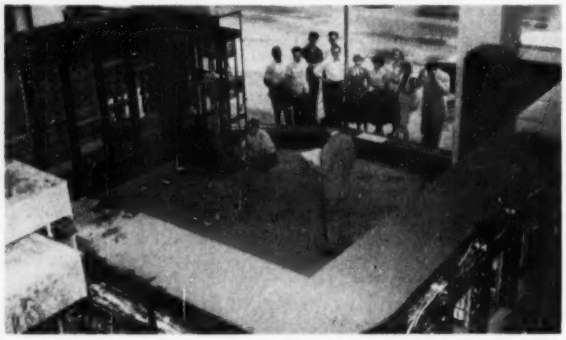
After the conclusion of the sessions, each registrant will receive a complete set of the lectures. It is expected that the advance registration will exceed the number that can be accommodated. Therefore, it is essential to register early.

Advance-registration forms can be obtained from Richard Rimbach, Electronic Computer Clinic, 845 Ridge Ave., Pittsburgh 12, Pa.

Computer Center in Phila.

PHILA., PA.—Philadelphia sidewalk superintendents take this rare opportunity to kibitz the construction of an electronic brain as they watch the Burroughs "UDEC II" take form at 1209 Vine St., Philadelphia. Already in place are most of the 648 building blocks or pulse units that give the computer its unusual unitized construction.

UDEC II (Unitized Digital Electronic Computer) will be operated in the showcase window to provide the only



major computation service available on a rental basis in the Greater Philadelphia area.

Work on UDEC II was begun June 12, when technicians began dismantling the company's previous computer—the three-year-old Burroughs Laboratory Computer—housed at 511 N. Broad St., in Philadelphia.

The system of cable connections (the pattern of logic) of UDEC II is that of an automatic, high-speed digital computer. But the 648 building blocks could be just as well connected to turn UDEC II into an automatic computer or into a master control to monitor the operations of an automatic factory.

UDEC II, in solving complex problems in design and analysis, handles numbers with as many as nine-digits. The C-shaped computer, seven feet high and sixty feet long, uses more than 3000 vacuum tubes and 7000 germanium diodes. A seven-and-a-half ton air-conditioning unit cools the components. The Burroughs computer can also memorize as many as 5300 nine-digit numbers and feed them back into a problem.

AVAILABLE—
A COMPLETELY NEW CONCEPT IN CONTROL VALVE DESIGN..

BODY RATING TO
50,000 PSI
FLOW RANGEABILITY
C_V .000001 TO 0.1

1 Substantial forged alloy (wide selection) valve body.
2 Rugged all stellite, easily removable, Flo-Mik valve seat.
3 Direct positive seal, inlet tubing to valve seat connection.
4 Hard chrome-plated, super finished valve stem with stellite plug.
5 Annin "Super VO" stem seal assembly.
6 Thumbset valve stem locking unit.
7 Powerful, lifetime lubricated, cross head and drive rod assembly.
8 Simplified combination stroke and valve action adjusting unit.
9 Direct and reverse acting stem stroke adjusting scale.
10 Needle bearing mounted motion converter arm.
11 Cross head pre-loading spring, eliminating lost motion.
12 Exclusive, extra strong, box type frame unit.

And now — Annin's "Wee Willie" — new in concept and design, providing the Research and Development engineer with a pilot plant instrument having a water Cv range from .000001 to 0.1 with control of pressures to 50,000 PSI. Unique design minimizes distortion, stretching, and friction. The time-proven Series "A" Domotor power unit provides precise and positive control under all conditions. "Wee Willie" may be the answer to your problems in the high pressure field. Investigate this new valve today!

"Wee Willie"
DOMOTOR
VALVES

Write today for bulletin No. 50WW for complete information and engineering data on "Wee Willie"

ANNIN
Control VALVES

THE ANNIN COMPANY
6570 E. TELEGRAPH ROAD, DEPT. A-234
LOS ANGELES 22, CALIFORNIA

For more information circle **14** on inquiry card.

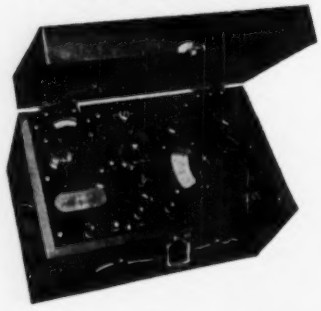
Precise
TEMPERATURE MEASUREMENTS

. . . with the Rubicon
MUELLER BRIDGE

A highly accurate and specialized form of the Wheatstone bridge designed expressly for precise resistance thermometry with three- or four-lead thermometers and for the measurement of other similar resistors within its range.

- Wide range: 0 to 141.1110 ohms in increments of 0.0001 ohm
- Unity ratio with provision for convenient checking and precise adjustment of ratio arms
- Built-in mercury commutator for lead resistance compensation
- Sub-panel switch construction
- Built-in plug and block assembly for conveniently checking ratio, bridge zero and thermometer resistance with no disturbance of external bridge connections

Described in Bulletin 100



. . . with the Rubicon
PORTABLE PRECISION POTENTIOMETER

A two-dial instrument of exceptional accuracy and sensitivity.

- High-sensitivity, sturdy, built-in Pointerlite galvanometer—permits balancing to within 2 microvolts in low resistance circuits
- Completely self-contained assembly—no external accessories except the thermocouple circuit
- Two ranges —0 to 16.1 and 0 to 161 millivolts—readable to within 2 and 20 microvolts respectively
- Sturdy, compact construction for long dependable service

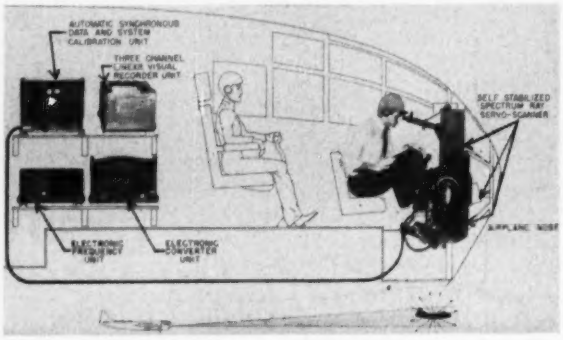
Described in Bulletin 270

RUBICON COMPANY
Electrical Instrument Makers
3755 Ridge Avenue Philadelphia 32, Pa.
For more information circle **15** on inquiry card.

Death-Ray Stratospheric Laboratory

NEW HYDE PARK, N. Y.—Servo Corporation of America of New Hyde Park, in cooperation with the United States Air Forces' Radiation Laboratory at Wright Field, Dayton, Ohio, has created a radical new military instrument —a flying laboratory capable of measuring and analyzing invisible radiations emanating from any missile or aircraft in flight. It will make these measurements up at the highest altitudes where only clear, cold blackness prevails.

All aircraft and missiles in flight radiate energies in many wavelengths. These rays can be detected. Mr. Henry Blackstone, President of Servo Corporation of America,


AUTOMATIC SYNCHRONOUS DATA AND SYSTEM CALIBRATION UNIT
THREE CHANNEL LINEAR VISUAL RECORDER UNIT
SELF STABILIZED SPECTRUM RAY SERVO-SCANNER
ELECTRONIC FREQUENCY UNIT
ELECTRONIC CONVERTER UNIT

says: "The era of Radar is dead in the sense that . . . it has been stripped of the advantage of secrecy. Military vehicles in the future will no more permit radar transmissions than would they turn on a blazing 800,000,000-candle-power searchlight. Enemy detection in the future will be confined to inescapable radiations created by the heat of engine power plants, the friction of air molecules against the vehicle's skin, or the reflection and silhouette of the sun's rays. When one of our aircraft uses its radar it can be detected hundreds of miles farther away by the enemy before it can detect the enemy. The military operations in the future must be based on secrecy and stealth."

These new equipments in the field of infrared radiation and measurement are made possible by new optical materials known as "Servofrax" glass, and new infrared detection devices known as "Servotherm" thermistor bolometers.

The flying infrared laboratory is gyro stabilized in space; no matter how the mother plane tosses and bounces, the scientific instruments remain unperturbed. Measurements can be made rapidly and automatically on whatever the target aircraft may be. The electronic ray analyzer is a precision double monochromator capable of analyzing the "black light." Included are multi-channel recorders and a precision calibration reference.

These equipments have quietly been created in the past eight years and brought to the state of practicality and perfection that was attained by radar. The flying laboratory is sufficiently compact and light to fit into the bombardier's compartment of a medium bomber.

Precision Gyro

MINNEAPOLIS, MINN.—Development and mass production of the most sensitive airborne instrument ever built —a new type "floated" gyroscope—was disclosed for the first time by the Minneapolis-Honeywell Regulator Company.

Performance of the new "floated" gyro—officially called the *Hermetic Integrating Gyro*, or *HIG* for short—approaches the fantastic:

It can detect motion 3,000 times slower than the movement of the hour hand on a watch; it can detect a tiny

It's Quality Deserves Consideration

FISHER® LEVEL-TROL®

UPPER and LOWER SIDE CONNECTIONS

TOP and LOWER SIDE CONNECTIONS

UPPER SIDE AND BOTTOM CONNECTIONS

Factory calibrating or zeroing adjustment produces a correct 3 to 15 pound signal output for full float range operation, as particularly required in liquid level indication. Output signal of controller is linear as related to level height change.

Simple level adjustment indicating dial.

Pneumatic proportional band and specific gravity adjustment combined in one member.

Small compact relay unit, minimum working parts.

★ All welds are in accordance with ASME code for unfired pressure vessels.

Universally Accepted for

- LIQUID LEVEL CONTROL
- LIQUID LEVEL INDICATION
- INTER FACE CONTROL

Engineered for peak performance the Fisher Series 2500 Level-Trol is designed to give rugged, trouble-free service. It is high in sensitivity and accuracy . . . it is versatile in handling all kinds of liquids, with minimum service attention.

Fisher Bulletin F-3 gives full details . . . write for your copy today!

FISHER GOVERNOR COMPANY • Marshalltown, Iowa

WORLD LEADER IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL

FISHER Since 1880

For more information circle **16** on inquiry card.

FOR IMMEDIATE DELIVERY

CLIFTON'S new size 10 synchro series at ½ the size and weight of size 15's

. . . yet at better accuracy and comparable price

Designed and produced by the same engineering team which built the original high precision synchro, this new series is a further step in the line of synchro development.

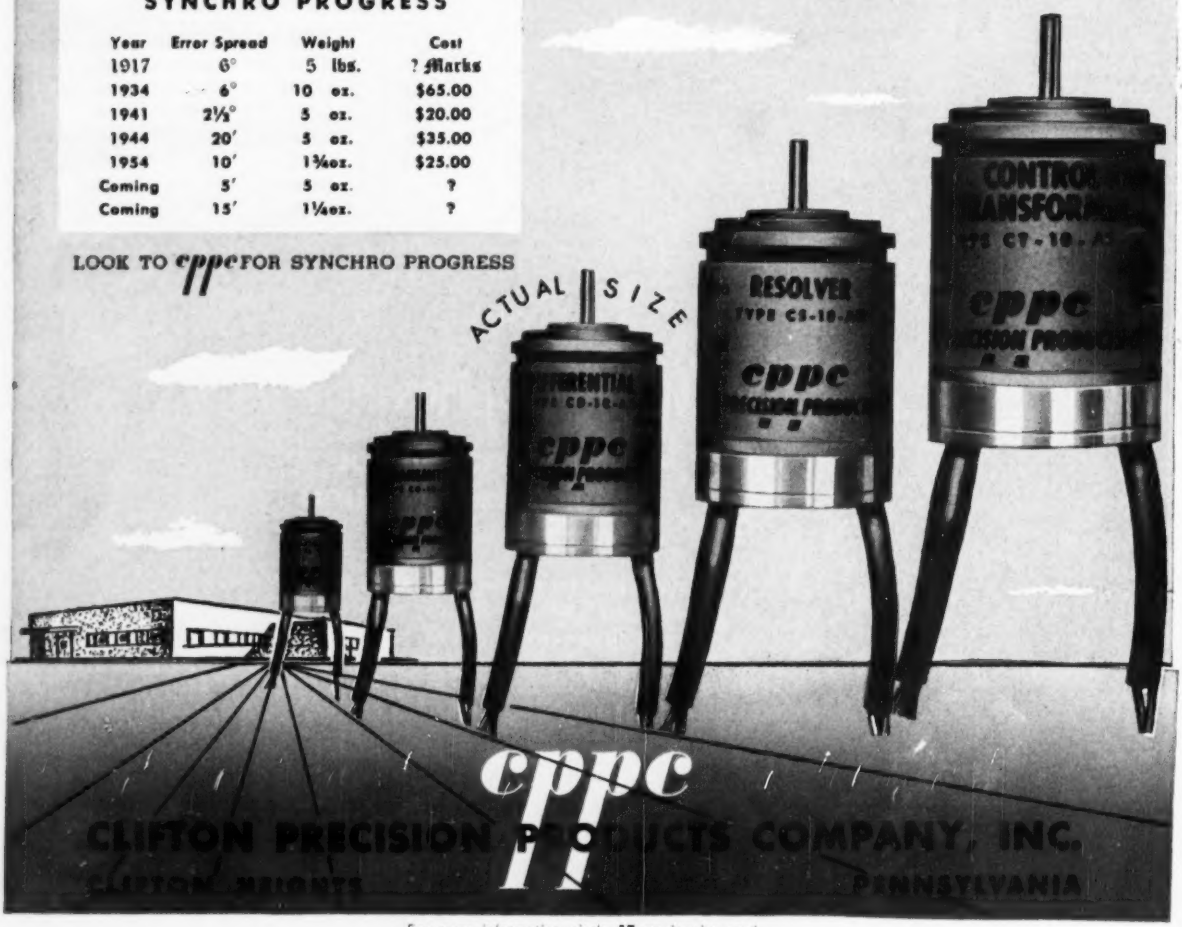
Full engineering information, drawings, electrical characteristics of these and our size 11 and size 15 series are available. We are also producers of miniature A.C. servo and D.C. motors for industry and the government.

Write or telephone A. E. Hayes, Sales Dept. Telephone (Phila.) MAdison 6-2101. West Coast Rep Wm. J. Enright, 988 W. Kensington Rd., Los Angeles 26, Calif. MUtual 6573

SYNCHRO PROGRESS

Year	Error Spread	Weight	Cost
1917	6°	5 lbs.	? Marks
1934	6°	10 oz.	$65.00
1941	2½°	5 oz.	$20.00
1944	20′	5 oz.	$35.00
1954	10′	1¾oz.	$25.00
Coming	5′	5 oz.	?
Coming	15′	1¼oz.	?

LOOK TO cppc FOR SYNCHRO PROGRESS



For more information circle **17** on inquiry card.

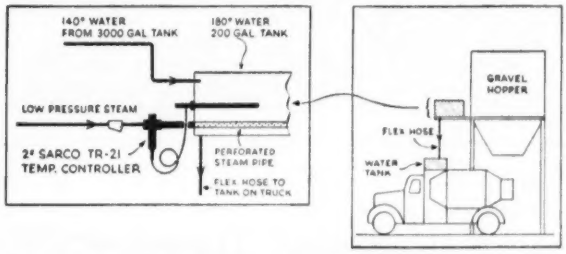
fraction of arc on the end of a radius as wide as the United States. To illustrate: if a man standing in Los Angeles could read an eight-column newspaper in New York, the gyro could detect the angle of change made by his eye as it traveled from the left-hand column to the right-hand column. The gyro accurately measures angles that are smaller than 1/36,000th of one degree of arc.

The speed of the gyro's tiny spin motor—the actual "heart" of the instrument—must be controlled with precision. To obtain the most accurate speed possible, the motor is tuned against a crystal oscillator which is accurate to better than one part in one million; this sound is constantly checked against WWV transmissions from the Bureau of Standards in Washington, D.C.

Despite its ultra precision and accuracy, the gyro is so rugged that it can withstand high shocks and stresses. Engineers have used a demonstration model of the gyro to drive nails through a board without affecting the instrument in any way whatsoever.

Concrete-truck Water Control

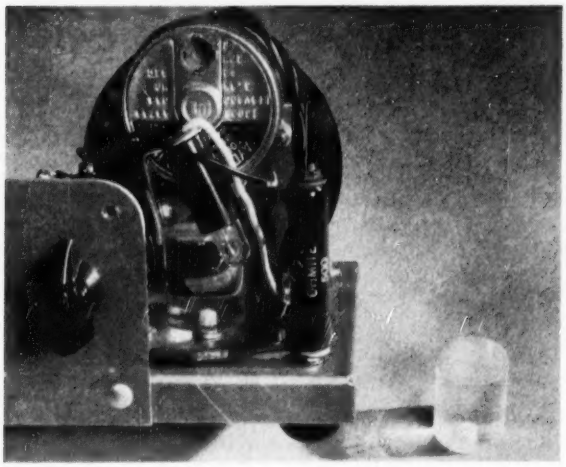
LONG ISLAND CITY, N. Y.—In cold weather, the water tank on a ready-mix concrete truck should be filled with 180-deg.-F. water to insure delivery of a concrete mix at



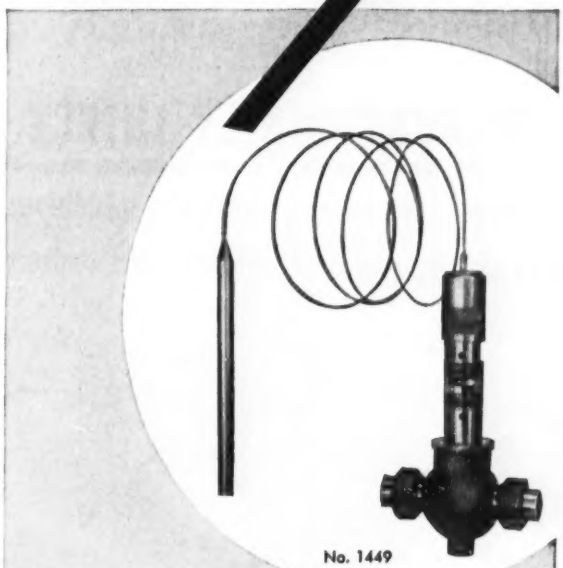
about 70-deg. F. However, the Principe D'Anna Corp. of Long Island City found it uneconomic to heat their 3000-gal. 140-deg.-F. water tank to the required 180 deg. A more economic solution was use of an auxiliary 200-gal. tank in which the 140-deg. water was raised to 180 deg. by injection of steam that is regulated by a self-operated temperature controller. A 2-inch "TR-21-500" self-operative controller of Sarco Co., Inc., Empire State Bldg., New York, was used.

Mechanical Heart

RIVERSIDE, CONN.—A 1-in.-diameter rod of clear "COCOR CR-39" allymer resin converts a pointed light into a narrow vertical beam in this "mechanical heart," a



new Klipfel tank thermostat valve



with 7 important advantages..

- LONG LIFE HARDENED METAL BALL INNER VALVE
- TROUBLE-FREE ONE-PIECE METAL BELLOWS
- BUILT-IN OVERHEAT PROTECTION
- QUICK, UNIFORM THROTTLING ACTION
- POSITIVE, TIGHT CLOSING
- WIDE SELECTION OF TEMPERATURE RANGES
- GENEROUS 50° ADJUSTMENT RANGE

For dependable, low-cost temperature control, select this NEW Klipfel Thermostatic Valve . . . perfected to give the service you want with accuracy, dependability and minimum maintenance. Write for complete details or request literature from your supply house or Klipfel Distributor, listed in the classified telephone directory.

NEW 2 MORE MONEY-SAVING KLIPFEL CONTROLS

No. 1549 — Pilot-operated Temperature Regulating Valve . . . sensitive, positive control for high pressure, larger sizes.

No. 1649 — Combination Temperature and Pressure Control . . . single main valve with temperature and pressure control saves cost and labor!

Trouble-Free Heart of the Valve

Rotating ball seats perfectly . . . is self-cleaning . . . gives streamlined flow!

Klipfel VALVES, INC.
1070 LINCOLN AVE.
HAMILTON, OHIO

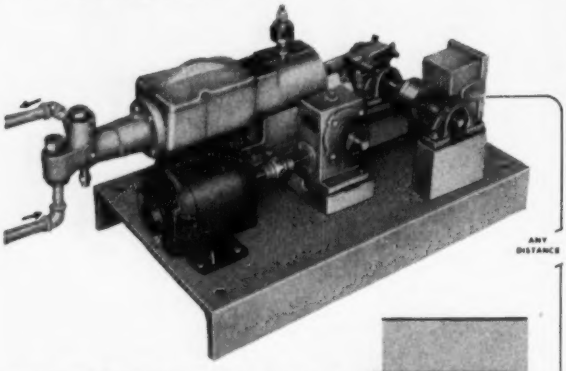
Export Office—1010 Schaff Building, Philadelphia 2, Pa.

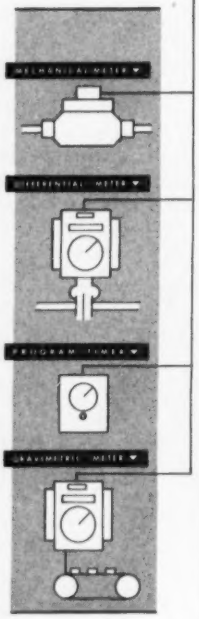
For more information circle 18 on inquiry card.

PROPORTIONALLY INJECT

Reagents • Detergents • Inhibitors • Additives

***...directly* without specialized controls**





PROPORTIONEERS new Adjust-O-Feeder automatically regulates the feeding of secondary fluids in proportion to variable demand. Fluctuations in the metered variable are converted to integrator contacts which in turn regulate the number of strokes of the Adjust-O-Feeder metering pump.

This new unit meters and feeds these secondary fluids in prescribed quantities and in proportion to process requirements as determined by the sensing elements shown.

Adjust-O-Feeder metering pumps are built in a wide range of sizes, types and materials of construction to suit any field problem requiring quantities from cubic centimeters to gallons per minute and against both low and high pressures.

Ask for information and recommendations. Proportioneers, Inc., 422 Harris Avenue, Providence 1, Rhode Island.

See us at the INSTRUMENT EXPOSITION in Philadelphia.

PROPORTIONEERS
DIVISION OF B-I-F INDUSTRIES, INC.
METERS FEEDERS CONTROLS

Technical service representatives in principal cities of the United States, Canada, Mexico and other foreign countries.

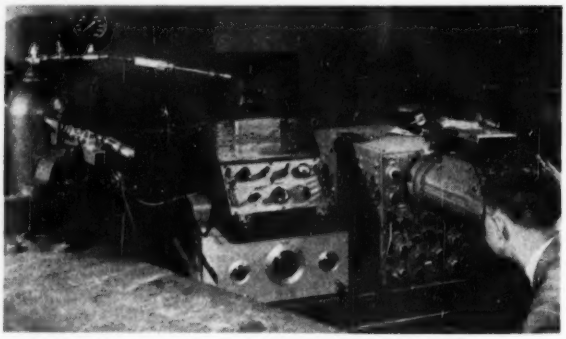
For more information circle **19** on inquiry card.

type of signal generator developed by Electro-Physical Laboratories, Inc., for use in testing and demonstrating their Cardiotron electro-cardiographs. This instrument translates the beam of light into electrical "heartbeats" by means of a photoelectric cell. A revolving timer wheel (Haydon), with a pattern of transparent openings, regulates the passage of light in a manner which approximates the rhythm of the human heart.

The plastic rod is a product of Cast Optics Corporation, Riverside, Conn.

Relief-valve Testing

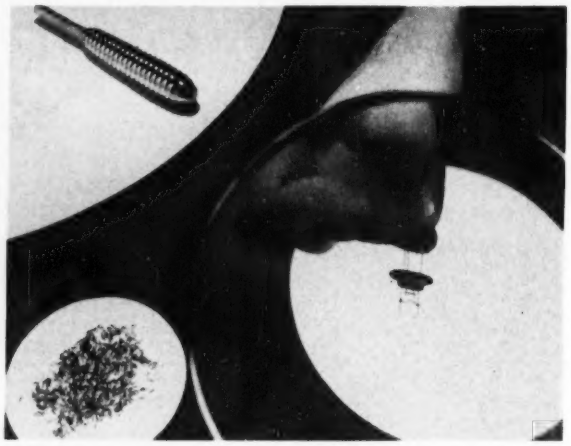
BELLEVILLE, N. J.—Engineer at the Walter Kidde Co. checks a pressure-relief (poppet) valve. Characteristics of



valve displacement versus line pressure are measured by use of a DuMont oscilloscope and a Hewlett-Packard oscillator.

"Rate-grown" Transistors

SYRACUSE, N. Y.—The General Electric Company announces that it is tooling for mass production (in the millions) of low-cost high-frequency transistors, using the



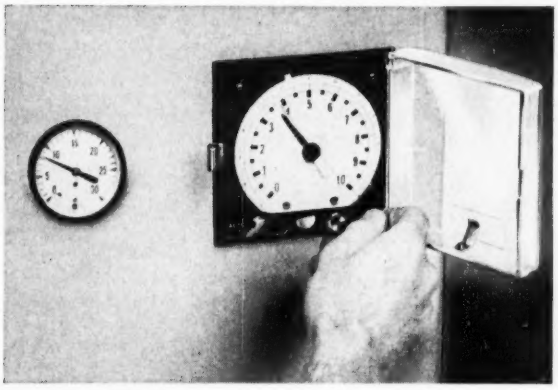
rate-grown process in which impurities are introduced while the crystal is growing. Dr. W. R. G. Baker, GE vice president and general manager of the company's Electronics Division, said that production in the millions will be underway within the next two years, depending on the speed at which the electronics industry designs circuits with transistors.

The ingot in the upper left of the illustration was produced in two hours by the rate-grown method, then sliced into tiny bars (one ¼-lb. ingot can produce 2000 transistors). The bar, with attached leads, is a transistor.

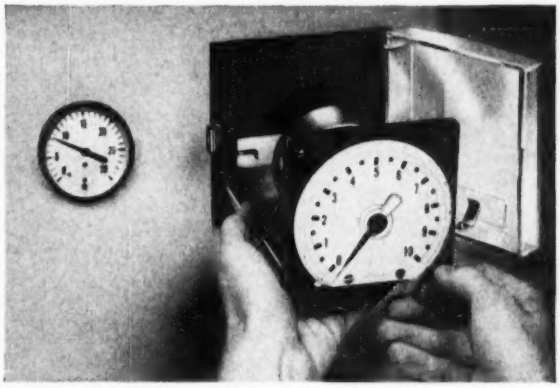
You can replace your Metagraphic indicator with a recorder—

in less than 10 seconds . . . with no pressure loss

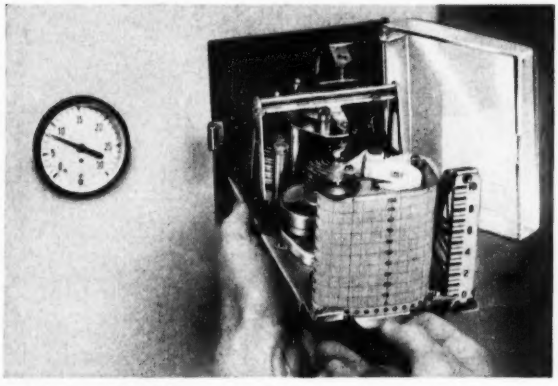
Let's say your graphic-panel-controlled process is at a critical stage. You've got a Metagraphic Indicator in the panel but now you want a *record* of every variation—and you can't afford to upset control. With Bristol's human-engineered Metagraphic system, here's all you have to do:



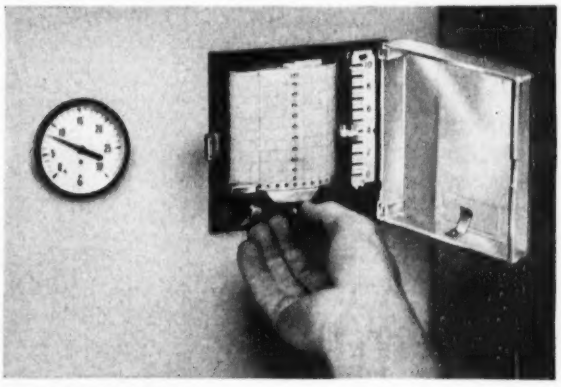
TIME—00:00 Open case door, twist retaining latch securing indicator chassis to case. (Note pressure gage reading.)



TIME—00:02 Pull out indicator chassis. Connections are automatically sealed off. Valve-top pressure stays constant.



TIME—00:05 Slide the Metagraphic recorder chassis into the case. All plug-in connections are made automatically. (Now note that the pressure gage still reads the same.)



TIME—00:08 Push recorder all the way in, fasten latch. Changeover is complete, with no pressure loss, no disturbance of control. In fact, you don't even have to go off automatic control.

434

And less than 10 seconds have elapsed! You can get the complete story on Bristol's Metagraphic instruments by writing for Bulletin A106. The Bristol Company, 113 Bristol Road, Waterbury 20, Conn.

BRISTOL

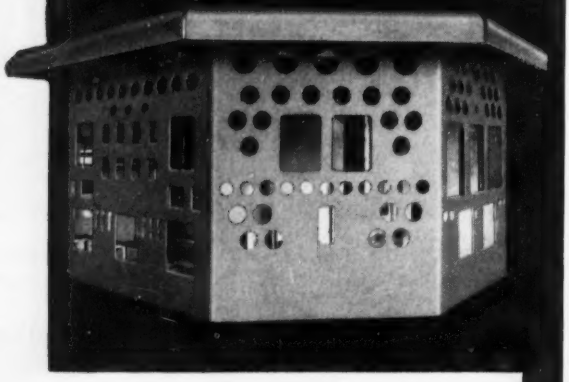
POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **20** on inquiry card.

Custom Built

electrical enclosures by KIRK AND BLUM



Whether you need one simple cabinet, a pair of control desks or a thousand precisely manufactured weatherproof housings, call on KIRK & BLUM for quick service.

Complete facilities for fabrication of sheet steel, plate, light structurals, stainless, aluminum, monel or other alloys.

Join the long list of plants which depend on KIRK & BLUM for sheet metal and plate fabrication.

For complete information...literature on fabrication facilities and experience ...write to: The Kirk & Blum Mfg. Co., 3111 Forrer Street, Cincinnati 9, Ohio.

CONTRACT MANUFACTURING FACILITIES for

- Boiler, Turbine and Generator Control Panels
- Power Distribution and Control Panels
- Switch Gear Housings • Instrument Panels
- Cubicles • Electrical Enclosures • Machine Bases
- Transformer Enclosures • Control Desks
- Weatherproof Housings • Breechings
- Air Ducts • Stacks • Casings • Hoppers

KIRK AND BLUM
METAL FABRICATION

For more information circle 21 on inquiry card.

Books...

DISCONTINUOUS AUTOMATIC CONTROL

Irmgard Flugge-Lotz

Princeton University Press, Princeton, N. J., 1953. Cloth, 168 pages, $5.00.

Eight chapters, mathematical, present differential equation of motion, description of controlling mechanism, complete theory of motion with position control and velocity control, and longitudinal motion of a missile (discontinuous position control.)

FUNDAMENTALS OF TRANSISTORS

Leomard Krugman

John F. Rider Publisher, Inc., 480 Canal St., New York 13, N. Y., 1954. Paper, 16 pages, $2.70.

Seven chapters treat basic semiconductor physics, transistors and their operation, grounded-base, grounded-emitter and grounded-collector transistors, amplifiers and oscillators, high-frequency, and other applications.

X-RAY DIFFRACTION PROCEDURES

H. P. Klug and L. E. Alexander

John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 1954. Cloth, 716 pages, $15.00.

Twelve chapters bring together the most useful manipulative and interpretative details of the sciences of crystallography and X-ray diffraction. Includes complete procedures for the various techniques and examples illustrating them.

HUMAN ENGINEERING GUIDE FOR EQUIPMENT DESIGNERS

Wesley E. Woodson

University of California Press, Berkeley 4, Calif., 1954. Paper, 268 pages, $3.50.

Five chapters, undergraduate level, cover design of equipment and workspace, vision, audition, body measurement, body sensitivity, movement and control, and orientation. Includes bibliography for design applications and suggested reference library.

MAGNETIC-AMPLIFIER CIRCUITS

William Geyger

McGraw-Hill Book Co., Inc., 330 W. 42 St., New York, N. Y., 1954. Cloth bound, 278 pages, $6.00.

Eighteen chapters, essentially nonmathematical, cover magnetic-amplifier elements, basic nonfeedback types of circuits, external-feedback types, internal-feedback types, second harmonic type, properties and applications of magnetic-amplifiers.

MATERIALS AND PROCESSES

James F. Young

John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y., 1954. Cloth bound, 1074 pages, $8.50.

Twenty-four chapters include fundamentals of materials and processes related to design, production, and control of products—metals, plastics, rubber, ceramics, casting, hot-working and cold-working process, welding, machining, gaging and testing.

ELECTROPHORESIS BIBLIOGRAPHY

Edited by Alfred Henley

Electrophoresis Div., American Instrument Co., Inc., Silver Springs, Md., 1953. Paper, 228 pages, $10.00.

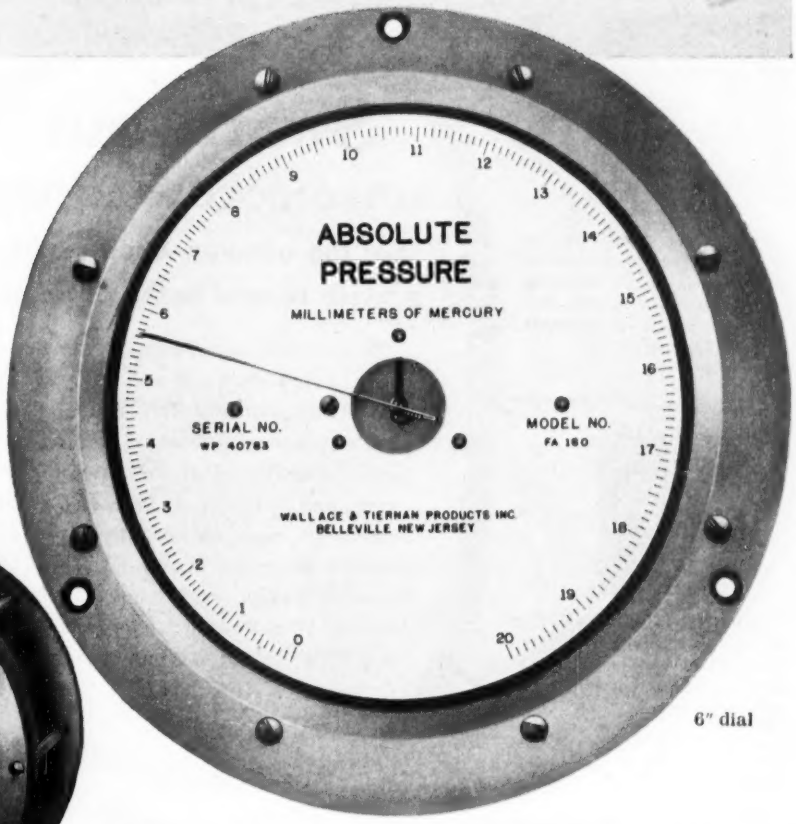
Four chapters list books, papers, etc., on all phases of electrophoresis according to subject classification and author. Sections include articles on theory, instrumentation, methods, and materials for application.

ABSOLUTE PRESSURE INDICATOR

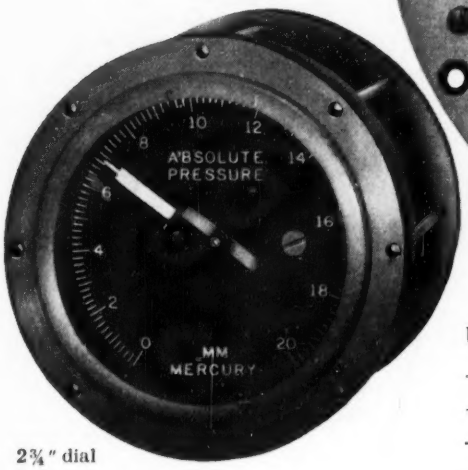
. . . FOR DEEP VACUUM WORK

Measures *pressure*
directly from
ZERO ABSOLUTE
to atmospheric

. . . swiftly and precisely



6" dial



2¾" dial

Used as a pressure indicator in any system employing a vacuum.

- All readings are relative to ZERO ABSOLUTE.
- Dial *reads directly.*
- Accurate to 1 part in 300 over full scale.
- Sensitive to 1 part in 500 in *all* ranges.
- No auxiliary indicator or corrections for ambient pressure changes required.
- Protected against sudden pressure surges.
- Ranges:

0.1– 20mm Hg.	0–200mm Hg.
0 – 50mm Hg.	0–410mm Hg.
0 –100mm Hg.	390–800mm Hg.

- Dial Sizes: All ranges in either 2¾" or 6" dia.

TYPE FA-160

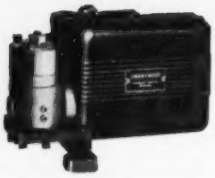
For additional information on W&T Absolute Pressure Indicators, write today for Publication No. TP-28-A.

WALLACE & TIERNAN
INCORPORATED
PRECISION INSTRUMENTS AND ELECTRICAL MECHANISMS
25 MAIN ST. BELLEVILLE 9, N. J.
In Canada: Wallace & Tiernan, Ltd., Toronto

A-102

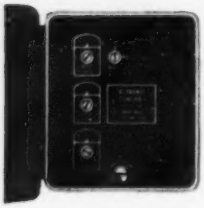
For more information circle **22** on inquiry card.

AUTRONIC TEMPERATURE TRANSMITTERS—Two types available: (1) T2C thermocouple converter for use with thermocouples. Bulletin A-712. (2) T2E resistance thermometer with T2A thermometer adapter including interchangeable range card. Bulletin A-706.



AUTRONIC PRESSURE TRANSMITTER—P2T pressure primary element for up to 5000 psi eliminates transmission lags. No friction, extremely low hysteresis. All-electric signal transmission. Bulletin A-708.

AUTRONIC ADAPTER UNITS—Swartwout makes several adapter units to utilize any a-c or d-c signal, such as strain gauges, pH, oxygen, etc., for use with the controller, recorder, or other Autronic components.



AUTRONIC CONTROLLER—Heart of the Autronic System. Instantaneous, all-electronic response. Proportional, automatic reset, and/or rate action adjustment ranges; with or without set-point. Bulletin A-702.

Swartwout

AUTRONIC COMPONENTS

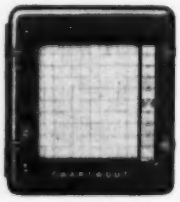
are the answer when rapid, precise control is the problem

Temperature . . . pressure . . . flow . . . pH . . . variable speed and many other control requirements. If it can be done by electro-mechanical or pneumatic means, it can be performed better, faster, easier, and generally at lower cost with Swartwout Autronic systems or components. Some are illustrated below. So if control and/or recording is your problem, call your Swartwout representative for a consultation at your convenience.

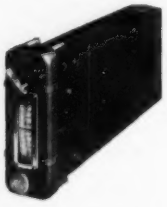
A-9851

AUTRONIC FINAL ELEMENTS—P2R power relay (above), an electro-pneumatic transducer, takes d-c control signal and converts it to proportional air loading pressure. Bulletin A-710A. Other electrical final elements supplied for variable speed motor control, magnetic amplifier, etc.

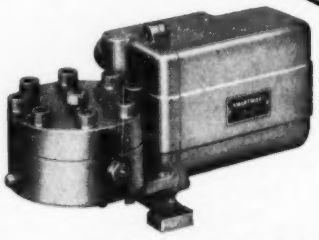
AUTRONIC INDICATOR—Rapid, accurate, miniature plug-in type instrument interchangeable with recorder. Supplied with or without set-point adjustment.



AUTRONIC RECORDER—Miniature plug-in type null-balance instrument gives true linear trace on 31-day strip chart. With or without set-point adjustment. Bulletin A-704.



AUTRONIC MANUAL CONTROL—Operates independently of recorder and controller. Continuous indication of valve position. Simplified switchover means bumpless transfer. Bulletin A-705.

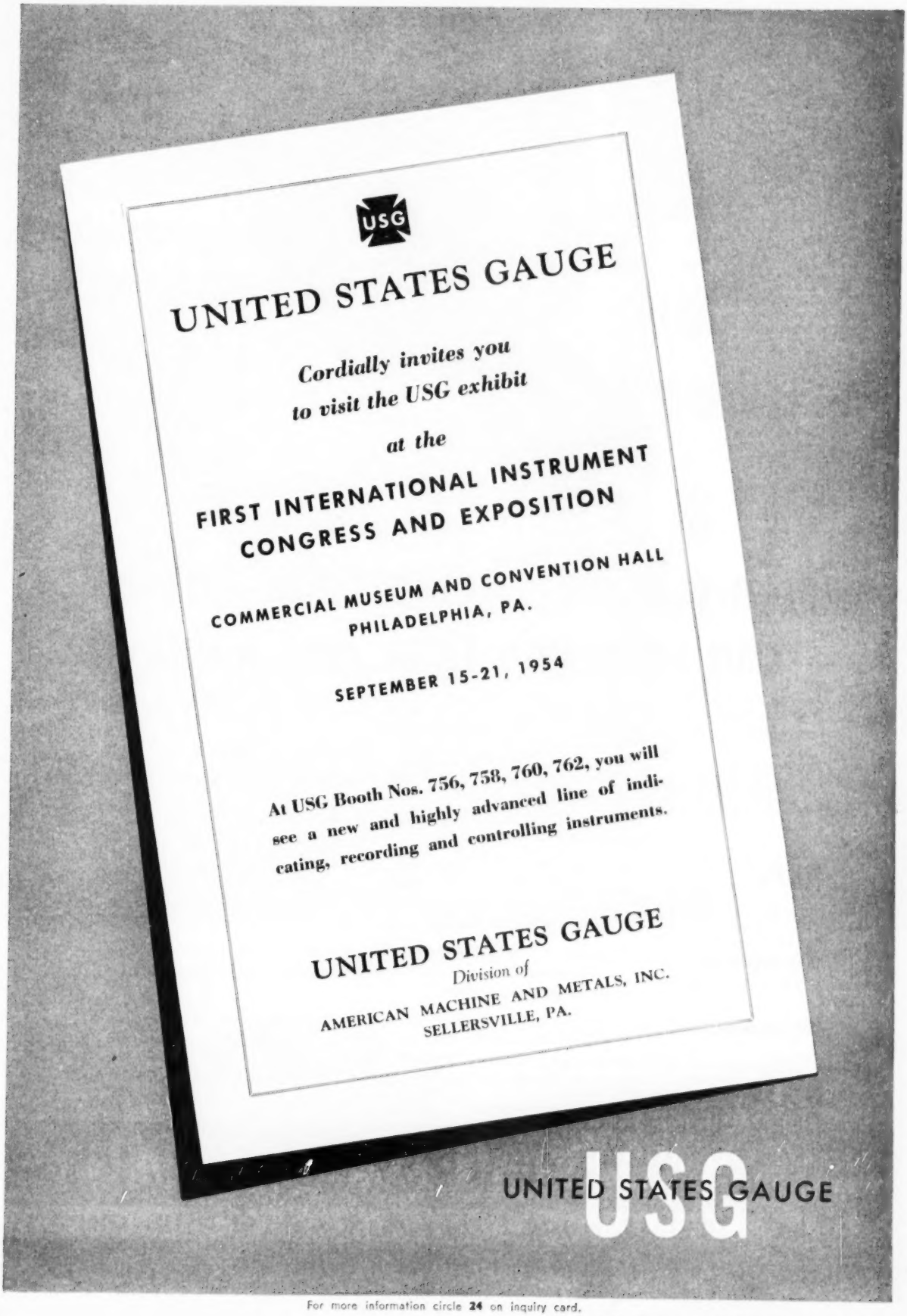


AUTRONIC DIFFERENTIAL PRESSURE TRANSMITTER—D2T transmitter with unique diaphragm pressure seal that eliminates bellows and torque tubes for extreme sensitivity at static pressures as high as 5000 psi. All-electric, no vacuum tubes. Bulletin A-707A.

Swartwout *Autronic* **CONTROL SYSTEM**

THE SWARTWOUT COMPANY • 18511 EUCLID AVENUE • CLEVELAND 12 • OHIO

For more information circle **23** on inquiry card.


USG
UNITED STATES GAUGE
Cordially invites you
to visit the USG exhibit
at the
FIRST INTERNATIONAL INSTRUMENT
CONGRESS AND EXPOSITION
COMMERCIAL MUSEUM AND CONVENTION HALL
PHILADELPHIA, PA.
SEPTEMBER 15-21, 1954
At USG Booth Nos. 756, 758, 760, 762, you will
see a new and highly advanced line of indi-
cating, recording and controlling instruments.
UNITED STATES GAUGE
Division of
AMERICAN MACHINE AND METALS, INC.
SELLERSVILLE, PA.
USG
UNITED STATES GAUGE

This Bailey Armortube* Cable can save you time and money

With this new material especially designed for pneumatic connecting lines you can make better instrument and control installations in less time and at less cost. Here's why:

Simple — Standard ARMORTUBE* cable is stocked in three convenient sizes: bundles of four, eight, or twelve ¼ inch O.D. aluminum alloy or copper tubes. Other sizes are available on special order. It's a ready-made, fully protected piping material for transmitting pneumatic signals between measuring units, instruments, and control units.

Safe — The flexible metallic covering guards against every hazard, internal or external. Patented rope-like arrangement of tubes eliminates danger of collapse at sharp bends—and damage from external blows or vibration is minimized by protective outer covering.

Compact — All necessary lines can be snaked through tight quarters or around corners with a minimum of connections. No need for unsightly, bulky channels, racks or other special mountings.

Economical — Installation is fast. 100 foot coils and 500 foot reels permit long unbroken runs. Colored tracer simplifies connections at terminals. Slightly higher first cost is quickly amortized by savings in materials, and installation time. For further information and specifications ask for Bulletin and Price List G91-9.

F-30

* Registered Trade Mark

BAILEY METER COMPANY

1041 IVANHOE ROAD • CLEVELAND 10, OHIO

INSTRUMENTS AND CONTROLS

For Power And Process

For more information circle **25** on inquiry card.

Librascope's

COMBINED TECHNIQUES

gives you faster, more efficient solutions to computer-control problems

What is the best possible solution to your individual computing-controlling problem? Do you require a handful or a roomful of equipment? Should the system be mechanical, electrical, electronic, magnetic or a combination?

Librascope has a broad background in all of these fields. By combining techniques applied successfully for nearly two decades in computing-controlling manufacture, Librascope is equipped to make an impartial evaluation of your problem and suggest the proper solution—one that will save you time and money and meet your most exacting requirements. Consult Librascope today.

MECHANICAL

Analog computing components. Sine-Cosine mechanism is one item of a complete line.

ELECTRONIC

Electronic devices for analog-digital computer-controls. The dual flip-flop is a typical example.

ELECTRICAL

Components for either analog or digital computers, typified by this Analog-Digital converter.

MAGNETIC

A complete line of magnetic amplifiers, magnetic decision elements and other magnetic computer components.

Engineers in search of interesting assignments, security, advancement—contact Dick Hastings, Personnel Director.

FOR EXAMPLE:

Librascope's Sine Wave Generator was designed for a major oil company. It is used to determine transfer functions of components in automatic control systems, and to define the physical properties of existing plants to which control systems are to be added. We solved this problem in minimum time and at moderate cost. If your industry requires equipment for computing or controlling designed around your individual problem, investigate Librascope's techniques.

LIBRASCOPE

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

LIBRASCOPE, INC. • 808 WESTERN AVE. • GLENDALE • CALIFORNIA

For more information circle **26** on inquiry card.

Veeder-Root Hand Tally counts anything you see. Press thumb lever once for each count. Reset to zero with one turn of knob. $8.30 ea. (Write for quantity prices.) Immediate delivery.

If this Clicks often enough... then the show clicks, too!

Added Evidence that—

Everyone Can Count on VEEDER-ROOT

275 laughs in 113 minutes . . . this was the certified count taken at a recent performance of a Broadway show by two executives of Fact Finders Associates, Inc. . . . both using Veeder-Root Hand Tallies.

This is another one of the hundreds of uses for each of the hundreds of Veeder-Root Counters which are made for manual, mechanical and electrical operation. Chances are that *you*, too, can count on Veeder-Root . . . with counters built into your products as standard parts, or attached to your production equipment. We'll help you to figure out how. Write:

VEEDER-ROOT INCORPORATED
HARTFORD 2, CONNECTICUT

Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities

"The Name That Counts"

For more information circle **27** on inquiry card.

ACHIEVED!

A Scanning System That Instantly, Graphically Presents All Process Variables

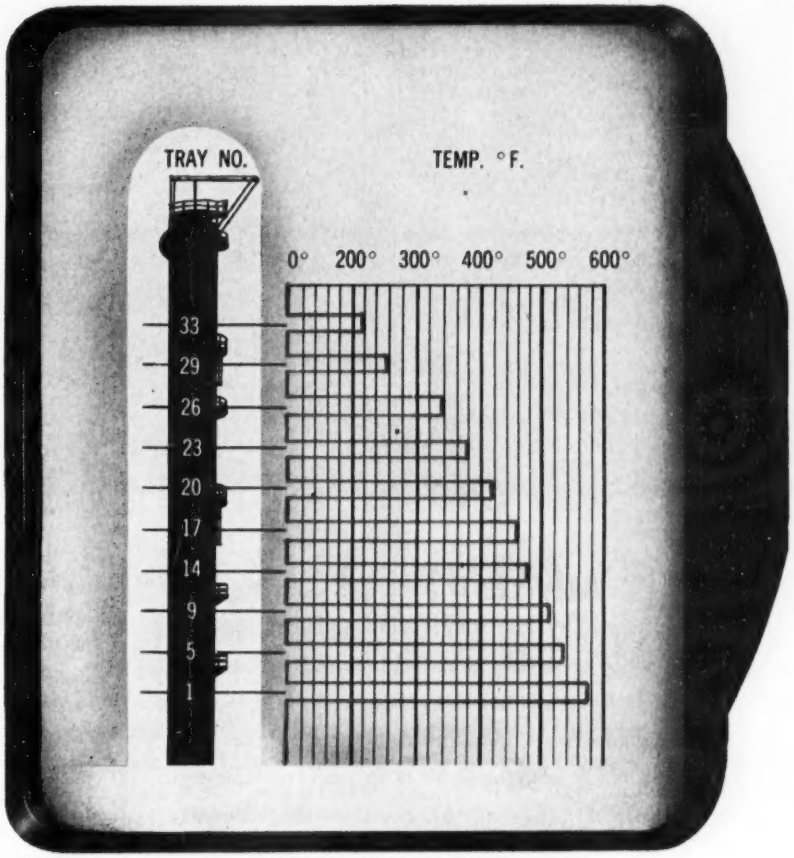
Now! Higher speed scanning than ever before with the Kybernetes Electronic Scanning System.* Permits graphic representation of all variables on scope. You see and hear your process operation.

Completely electronic. Scans each of any number of points 60 times per second. You secure uninterrupted scanning, continuous protection and alarm indication throughout logging, recording, and point reading. There is continuous qualitative and quantitative scope display of all process variables. The Kybernetes Electronic Scanning System is readily miniaturized and JANized for airborne and other equipment.

Transmitters, 8″ x 8″ x 12″, are packaged in convenient 4 point plug in units.

You may use the Kybernetes Electronic Scanning System to more efficiently and effectively monitor temperature, flow, level, pressure, viscosity, pH, concentration, conductivity, radiation, gas analysis, and other process variables.

For Specific Information applicable to your own monitoring requirements, write today.



This illustration shows just one of many Kybernetes Electronic Scanning System applications: signal sources from trays of fractionating column. Two or more trains of pulses may be simultaneously exhibited on one viewing tube.

The KYBERNETES Corporation · DIVISION OF SELF WINDING CLOCK CO., INC. (*PATENT PENDING)
1100 RAYMOND BOULEVARD, NEWARK 5, NEW JERSEY (OPPOSITE PRR STATION)

For more information circle **28** on inquiry card.

see for yourself
why ordinary aluminum optical coatings can't compare with the new
Miraloy
make this simple test:
1 Compare surface hardness of a Miraloy mirror—an exclusive Houston Technical Laboratories product—with that of an ordinary aluminum coated mirror by drawing a pencil point or other sharp object firmly across the surface of each mirror.
2 Coated side down, hold each mirror directly over the flame of a match.
3 Rub both mirrors with a linen handkerchief or other rough fabric.
4 Now — using a magnifying glass — examine the surfaces of both mirrors and see the difference. After undergoing the abuse described above, the extra-hard Miraloy surface — which compares favorably in hardness to Rhodium coatings — will win by a wide margin over ordinary aluminum coatings.

Miraloy is the new optical coating developed by Houston Technical Laboratories to provide a hard, corrosion and heat resistant coating for first surface mirrors. Exhaustive comparison by all known hardness, abrasion and corrosion tests have proved it far superior to all other standard coatings. And, in all ranges of the spectrum, its reflectivity is equivalent to pure aluminum. **Yet Miraloy costs no more than ordinary aluminum coatings.**

write for sample to make this test! At your request, we shall be glad to supply you with a sample mirror that has been coated with *Miraloy*. You are urged to subject it to the rigorous test described above. We also invite your inquiries about other HTL optical components. HTL precision lenses and mirrors can be made to your specifications.

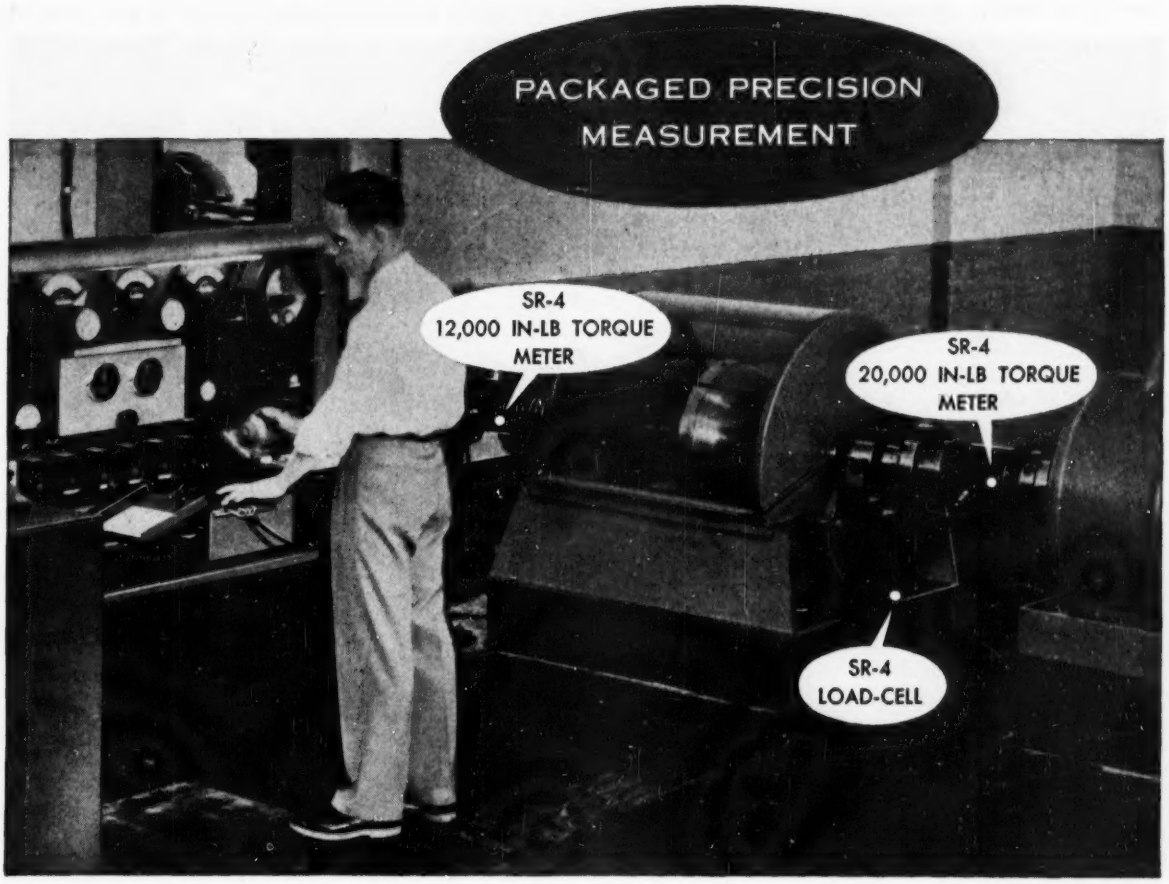
HTL

HOUSTON TECHNICAL LABORATORIES

A SUBSIDIARY OF TEXAS INSTRUMENTS INCORPORATED

2424 BRANARD • HOUSTON 6, TEXAS, U.S.A. • CABLE: HOULAB

For more information circle **29** on inquiry card.



National Supply measures torques and thrusts accurately and easily with SR-4® system

At their Toledo plant National Supply Company is using Baldwin SR-4 Torque-meters and Load Cells to measure torques and thrusts during development of torque converters. They report that the torquemeters are both accurate and convenient in measuring the efficiency of their new converters. Calibrations of load cells resulted in satisfactory reports.

By using Baldwin's SR-4 Torque Measuring System, National Supply benefits in three ways: (1) *reliable accuracy* over wide torque range. (2) *convenience* because of easy mounting. (3) *trouble-free operation* due to rugged construction and absence of moving parts.

You will profit, too, by using *Baldwin Packaged Precision Measurement.* Write now for our new booklets which will tell you how you can benefit by using SR-4 Device systems to measure electronically either load, torque or fluid pressure. Write to Department 3315, Baldwin-Lima-Hamilton Corporation, Philadelphia 42, Pa.

For the latest news on "Packaged Precision Measurement" visit Baldwin's Booth 201-203 at the First International Instrument Exposition, Convention Hall, Philadelphia, Sept. 15-21 incl.

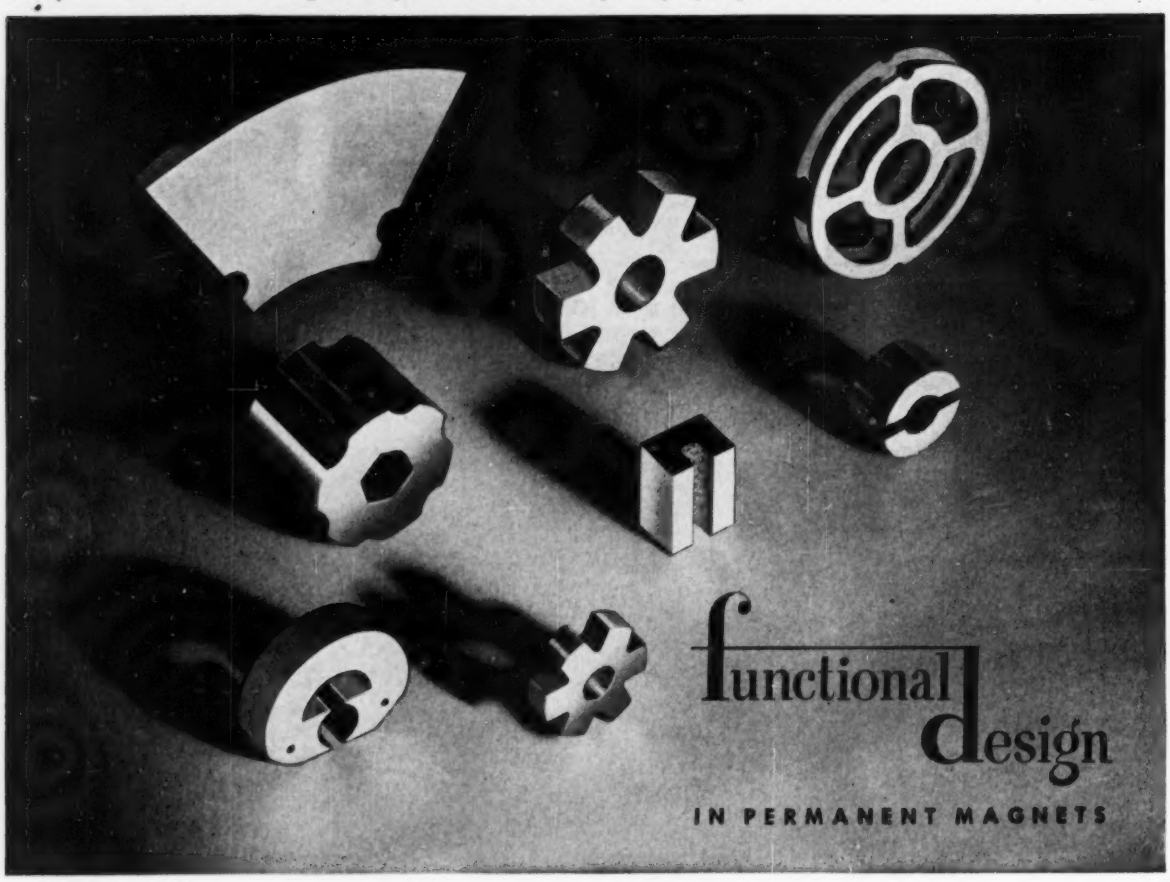
BALDWIN-LIMA-HAMILTON

General Offices: Philadelphia 42, Pa. • Offices in Principal Cities

In Canada: Peacock Bros., Ltd., Montreal, Quebec

For more information circle **30** on inquiry card.

ONE IN A SERIES: discussing the importance of selecting the proper permanent magnet to use in your product



Why SOUND, FUNCTIONAL MAGNET DESIGN guarantees superior product performance

Magnets must be "tailored" to your product . . . tailored in size, shape, and the material used . . . if greatest efficiency, at the lowest possible cost, is to be expected.

The magnet assemblies shown above are typical of such "tailoring." Those used in test meters, for example, are designed specifically to maintain a magnetic field of uniform high energy, so necessary to the precise operation of such meters.

Others—for holding applications—are designed so that their magnetic circuits provide the greatest possible tractive power. In applications where the magnet acts on moving parts of an assembly, still different designs may be required.

Our engineers—specialists in permanent magnet design and application—welcome the opportunity to assist you with your designs. For their recommendations—without cost or obligation—write us today. Or return the coupon below for a free copy of the helpful article, "Selecting the Proper Permanent Magnet Material for Your Product."

THE INDIANA STEEL PRODUCTS COMPANY
Valparaiso, Indiana

World's Largest Manufacturer of Permanent Magnets

INDIANA PERMANENT MAGNETS

The Indiana Steel Products Co., Dept. 9D
Valparaiso, Indiana

Please send me a free copy of "Selecting the Proper Permanent Magnet Material for Your Product."

Name_____ Title_____

Company_____

Street_____

City_____ Zone_____ State_____

For more information circle **31** on inquiry card.

Case No. 63

Kemp Oriad Dryer Gives "Most Satisfactory Service" Guarding Spencer Control Board

How Kemp assures round-the-clock operation at Spencer Chemical

The Spencer Chemical Co., Charlestown, Ind., operates 24 hours a day, 7 days a week, making nitrogen compounds for the fertilizer industry. Heart of this operation is the master instrument board that controls all plant processes. These instruments are operated by compressed air, which must be dried to prevent rust and corrosion within the controls.

Kemp Offers Continuous Protection

Spencer uses a Kemp Oriad Dryer to dry all the air required and completely protect the delicate instruments from moisture damage. Since its installation in 1950, this Kemp unit has needed no service of any kind. And Spencer is delighted with Kemp's ease of operation! Mr. N. S. Whitaker, Works Manager, commenting on Kemp's "most satisfactory service," says, "Operation is simplicity itself. All we have to do is switch a lever once a week. Capacity is ample for one week of maximum flow, on a 24-hour 7-day operation."

Kemp Dryers for Every Purpose

Kemp offers a variety of dryer models to meet all problems. Designed to dry air to sub-zero dew points at low cost, these efficient dryers embody the engineering knowledge gained from Kemp's many years of experience. They are available with manual, semi-automatic, or fully automatic tower reactivation. In addition, Kemp will prescribe the proper desiccant for each specific drying job. If you have a problem involving the drying of air, gases, or liquids, contact Kemp engineers now.

Only operation required on Kemp Oriad Dryer is moving lever once a week to switch flow of air to second column. First column is reactivated by heat during the week.

For more complete facts and technical information, write for Bulletin D-27 to: **THE C. M. KEMP MFG. CO., 405 East Oliver Street, Baltimore 2, Md.**

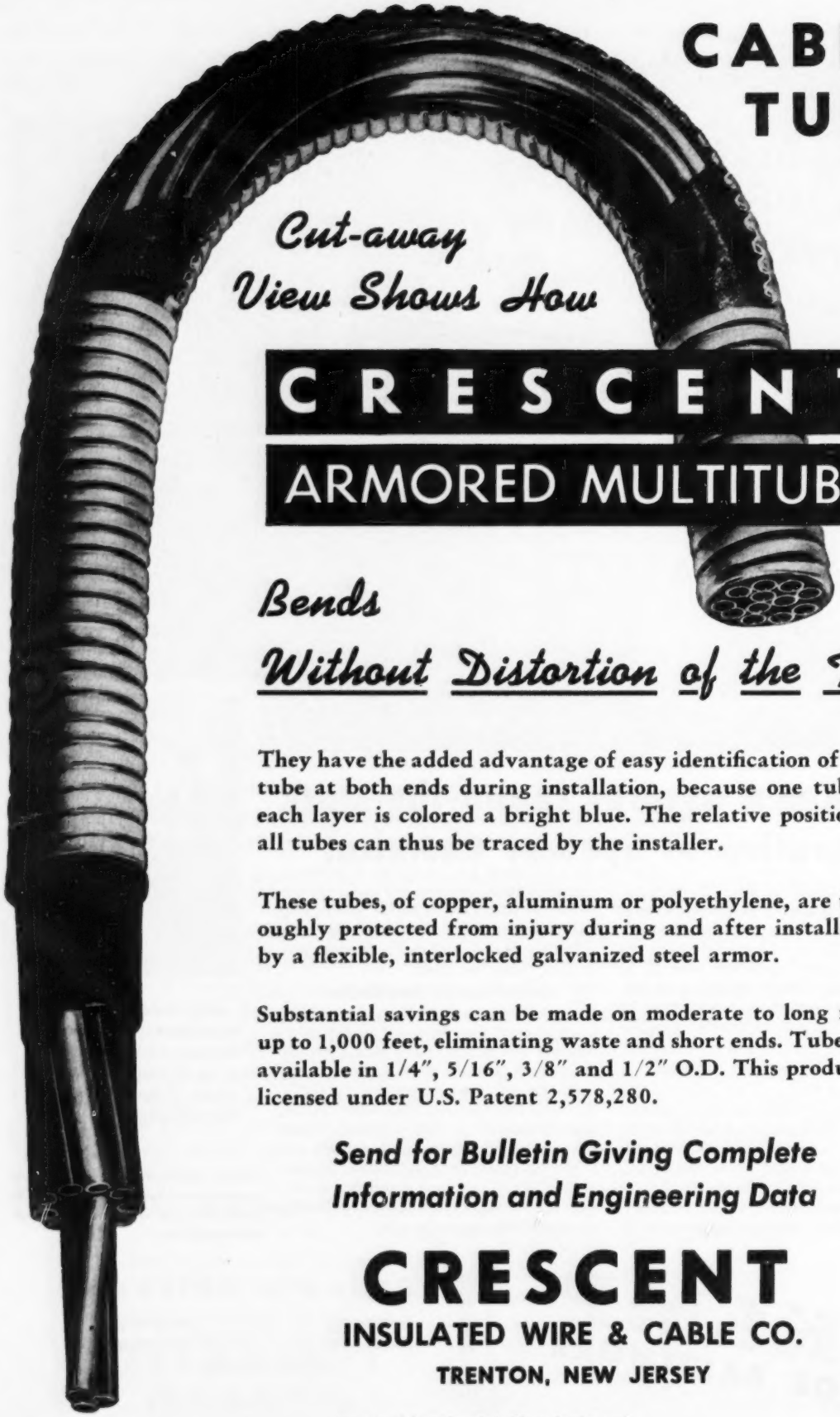
KEMP OF BALTIMORE

DYNAMIC DRYERS

CARBURETORS • BURNERS • FIRE CHECKS
METAL MELTING UNITS • INERT GAS GENERATORS
SINGEING EQUIPMENT

For more information circle **32** on inquiry card.

CABLED TUBES



Cut-away View Shows How

CRESCENT ARMORED MULTITUBE

Bends Without Distortion of the Tubes

They have the added advantage of easy identification of each tube at both ends during installation, because one tube in each layer is colored a bright blue. The relative position of all tubes can thus be traced by the installer.

These tubes, of copper, aluminum or polyethylene, are thoroughly protected from injury during and after installation by a flexible, interlocked galvanized steel armor.

Substantial savings can be made on moderate to long runs, up to 1,000 feet, eliminating waste and short ends. Tubes are available in 1/4", 5/16", 3/8" and 1/2" O.D. This product is licensed under U.S. Patent 2,578,280.

Send for Bulletin Giving Complete Information and Engineering Data

CRESCENT
INSULATED WIRE & CABLE CO.
TRENTON, NEW JERSEY

For more information circle **33** on inquiry card.

TRANSAIRE® Pressure Transmitter solves these tough problems!

Measuring within ½% of 20-40 psi shiftable range spans

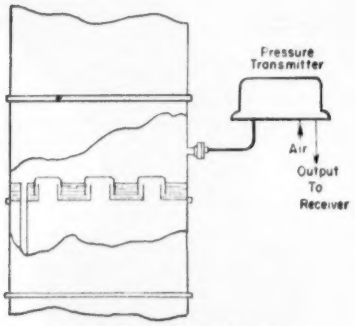
THE Taylor TRANSAIRE Pressure Transmitter with short, shiftable spans gives unprecedented accuracy and sensitivity—plus the convenience of suppressed ranges at high pressure levels. Operating on the simple force-balance principle, it will measure and transmit minute pressure changes up to 1,000 ft. It's accurate to ½% of the selected short range span and sensitive to pressure changes of ½" water.

THREE IMPORTANT ADVANTAGES

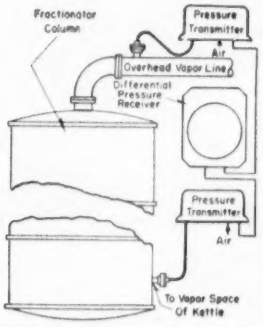
1. Range spans of 20 and 40 psi are available throughout the range limits of 35 to 415 psia; 50 to 100 psi throughout 100 to 1,000 psia.

2. The volumetric type pressure system is extremely accurate, practically clog-proof, has a corrosion-resistant 316 stainless steel diaphragm.

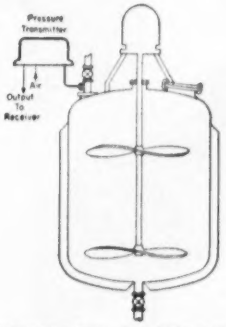
3. Temperature and barometric compensation make for higher accuracy of measurement, and consequently closer control.



COLUMN PRESSURE



COLUMN PRESSURE DROP



REACTOR PRESSURE

NARROW RANGE SPAN DETECTS PRESSURE TRENDS

Problem: To get highest possible purity of product consistent with good production economy. This requires the quick detection of pressure trends over a very narrow range.

Solution: The short, shiftable range spans (as short as 20 psi) of the TRANSAIRE Pressure Transmitter permit selection of operating range by a simple screw-driver adjustment. Its high order of sensitivity enables the operator to detect minute changes of pressure.

Result: Close control, because the minute pressure trends are practically instantaneously detected and transmitted to the controller and receiver. This means higher yield of a purer product, also great flexibility in changing to different product requirements.

PERMITS MAXIMUM CAPACITY OPERATION

Problem: To operate a column at maximum capacity, consistent with the preventing of flooding.

Solution: As the pressure drop across the column is a measure of the vapor velocity, the measurement of this drop with a short-range, highly sensitive, easily adjustable instrument enables the operator to keep the column safely close to the flooding point.

Result: Maximum production and uniform operation.

FLUSH SURFACE IS CLOG-PROOF

Problem: To measure pressure in reactor kettles containing viscous or corrosive liquids which tend to clog conventional measuring systems.

Solution: The closed volumetric measuring system of the TRANSAIRE Pressure Transmitter presents a flush surface on the inside of the vessel. It is clog-proof, highly sensitive and provides an accurate reading.

Result: Maximum yield of high purity product and a precise knowledge of the pressures maintained

---

Ask your Taylor Field Engineer, or write for **Bulletin 98097.**
Taylor Instrument Companies, Rochester, N.Y., and Toronto, Canada.

Taylor Instruments MEAN ACCURACY FIRST

For more information circle **34** on inquiry card.

Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters

Here is Why!

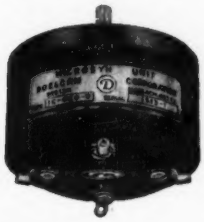
You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

- No oil filters.
- No dust filters.
- No internal lubrication to contaminate air handled.
- No internal wearing parts.
- No valves, pistons, or vanes.
- Non-pulsating pressure.
- Original performance constant over a long pump life.
- Low maintenance cost.

NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.

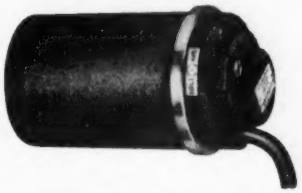
Write for Bulletin MP4



MICROSYN POSITION INDICATORS linearly transform an angular displacement into an electrical signal for application in fire control systems and gyro instrumentation.

Resolution to less than 1 100 of 1 degree

Write for Bulletin KG4



TYPE K RATE GYROS measure absolute angular rates about any one axis for flight test evaluation or control of aircraft. They are also proven components for use in control and homing systems in guided missiles.

Accurate to ¼ of 1% of full scale

Write for Bulletin S4

SYNCHROS size 11 (1.062" O.D.) 115 volt, 400 cps Control Transmitters and Transformers are approved standard military components (MIL-S-16892). Other sizes and types are also available.

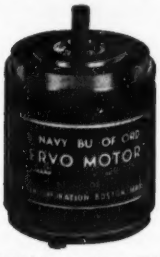
Average electrical error — 5 minutes of arc

Write for Bulletin CFG4

CAGEABLE FREE GYROS are designed expressly for guided missile applications. They are available with either Synchro or Potentiometer type pickoffs.

Drift is less than ¼ degree/minute

Write for Bulletin SM4



SERVO MOTORS two-phase, 115 volt, 400 cps fulfill the requirements of MIL-S-17087 (BuOrd). Available in sizes from 1.062 inches O.D. to 1.750 inches O.D.

Acceleration 33,800 radians/second²

Write for Bulletin VF4

VFDD POWER SUPPLY – DEMODULATOR serves as a link between sensing instruments and recording equipment. With the DOELCAM Type K Rate Gyros it comprises a complete system for flight evaluation of military aircraft.

Voltage regulated to 1%
Frequency stabilized to 0.2%
Demodulators linear to 1%

Doelcam

Master-precision

MILITARY COMPONENTS

IN EVIDENCE of the exceptional performance of DOELCAM *Master-precision* components, a measure of accuracy is presented with each unit illustrated. Tested and perfected for military use, DOELCAM electromechanical instruments for measurement and control are now standard components in automatic pilots, guided missiles, airborne instrumentation and fire control computers. DOELCAM's expanded manufacturing facilities now make it possible to offer these *Master-precision* components in production quantities for military applications. An outstanding engineering staff with broad experience in the field of instrumentation is available for assistance on your specific problem. For more detailed information — *write for bulletins.*

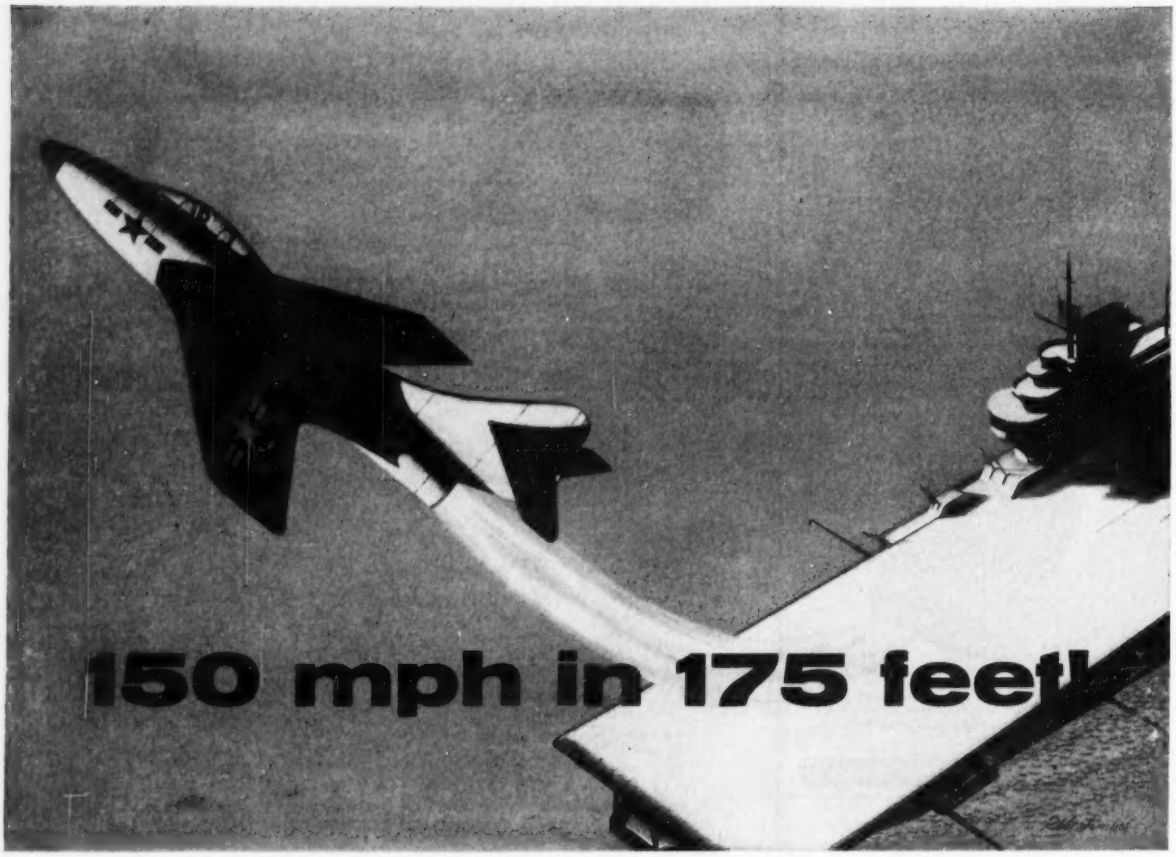
Doelcam CORPORATION

SOLDIERS FIELD ROAD, BOSTON 35, MASS.
West Coast Office: 304 Tejon Pl., Palos Verdes, Calif.

Instruments for Measurement and Control

Synchros • Gyros • Servos • Microsyns • Servo Motors

For more information circle **35** on inquiry card.



That is the speed at which the latest steam catapult launches a jet fighter. Such speed requires precision and split-second action to control the temperature and pressure of the steam which drives the catapult. Hagan Automatic Control has been chosen for this important function.

This is just one of the many specialized applications for which versatile Hagan control systems are ideally suited. A few recent applications of Hagan Automatic Control to aeronautical and automotive test facilities are listed below.

- Automatic control systems for subsonic and supersonic wind tunnels.
- Automatic control systems for accessory and component test facilities.
- Automatic control systems for steady state, blowdown and trajectory tests in turbojet, turboprop and ram jet test facilities.
- Automatic control systems for burner stands.
- Automatic control systems for parallel and/or series operation of blowers and exhausters.
- Programmed control systems for simulated flight conditions and trajectory tests.
- Automatic controls for gas turbines.
- Automatic control of pressure, pressure ratio, temperature and mass flow.
- Direct reading mass flow meters for both air and fuel, with automatic correction for variable pressure, temperature and density.
- Automatic resolution of multiple wide range correction factors into a single correcting signal.
- Measurement and control of gas flow, with automatic correction for pressure and temperature variation.
- Jet engine and rocket thrust measurement.
- Portable thrust stands for aircraft thrust measurement.

HAGAN CORPORATION

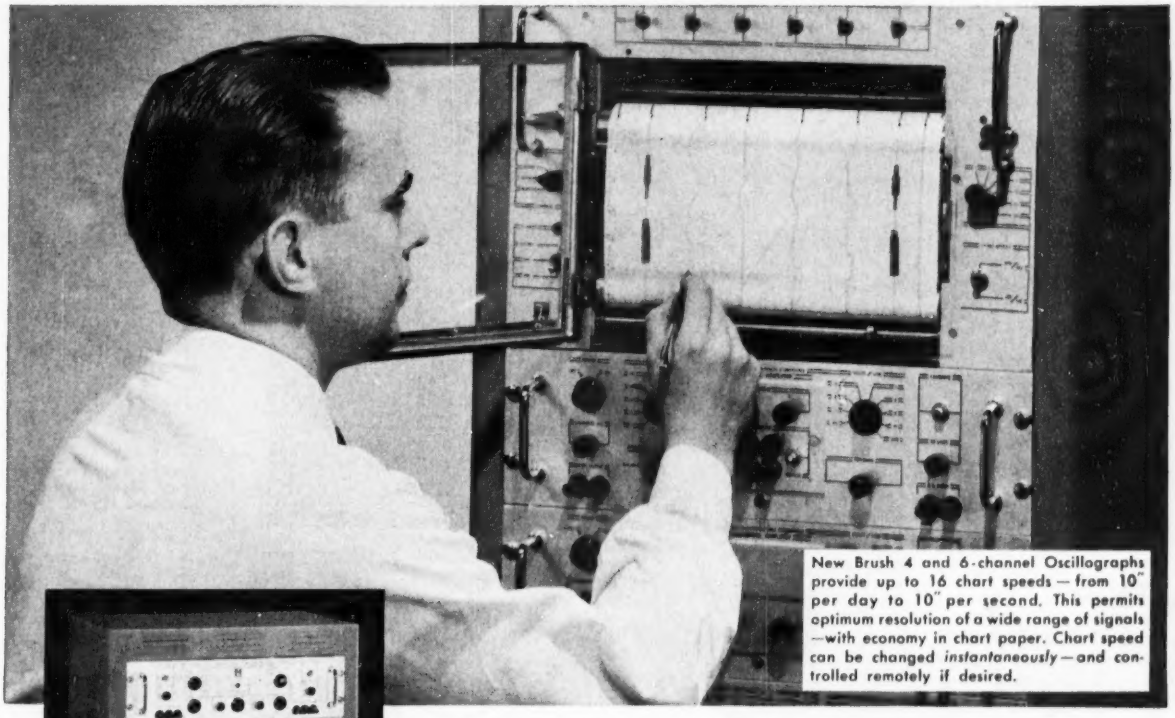
HAGAN BUILDING. PITTSBURGH 30, PENNA.

AERONAUTICAL AND SPECIAL PRODUCTS DIVISION

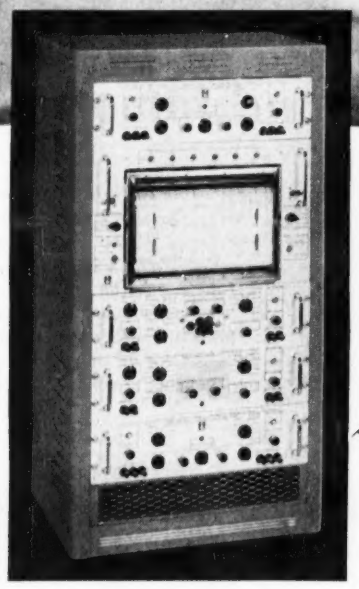
HAGAN HALL BUROMIN CALGON

For more information circle **36** on inquiry card.

FULL RANGE INSTRUMENTATION!

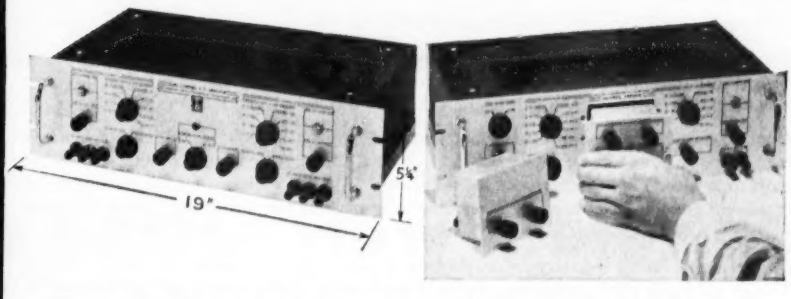


New Brush 4 and 6-channel Oscillographs provide up to 16 chart speeds — from 10" per day to 10" per second. This permits optimum resolution of a wide range of signals —with economy in chart paper. Chart speed can be changed *instantaneously* — and controlled remotely if desired.



New Brush Recording Systems are designed to meet many mounting requirements — standard 19-inch racks, bench-top, or floor consoles. New Brush Amplifiers are lighter, smaller and can be stacked closely as shown.

NEW BRUSH RECORDING SYSTEMS *offer you greatest flexibility in measurements*



Above: New Brush dual-channel D. C. Amplifier Model BL-530 accepts either single ended or balanced signals, provides a 50 millivolt sensitivity and accurate calibration of the signal to be recorded.

Right: New Brush Universal* Amplifier Model BL-520, when used with the appropriate resistive or inductive transducer, permits measurement and direct recording of physical phenomena: strain, torque, force acceleration, velocity, displacement, pressure, temperature, etc. Maximum sensitivity is equivalent to ½ microvolt per chart millimeter; or in strain measurements — .25 microinch per inch. The Amplifier includes a medium gain direct-coupled amplifier section with calibrated attenuator that may be used separately for voltage and current measurements.

*Trade Mark

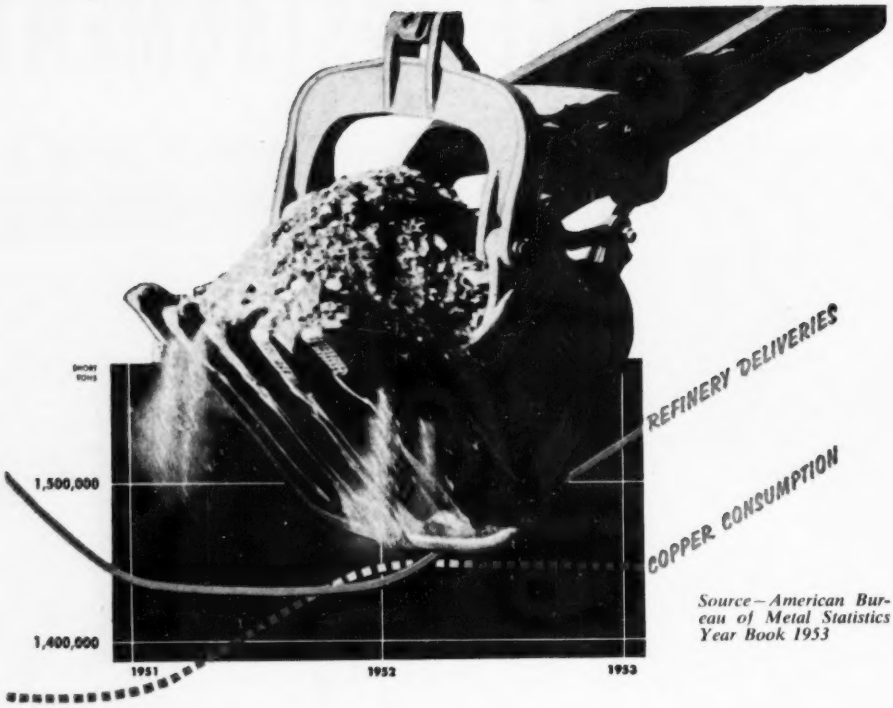
Brush Recording Systems have an important place in your research and production instrumentation. Write today or call your nearby representative for complete information. Brush Electronics Co., Dept. A-9, 3405 Perkins Avenue, Cleveland 14, Ohio. In Canada: A. C. Wickman, Ltd., Toronto

BRUSH ELECTRONICS COMPANY

INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZO-ELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT
ULTRASONIC EQUIPMENT

formerly The Brush Development Co. Brush Electronics Company is an operating unit of Clevite Corporation.

For more information circle **37** on inquiry card.



Source—American Bureau of Metal Statistics Year Book 1953

Plenty of Copper... today and tomorrow

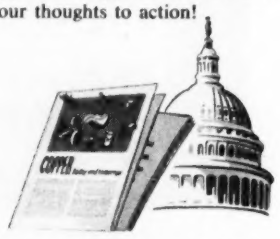
The assurance that copper is in abundant supply and *can be used without restrictions* is the "go ahead" for industry. You can now rate PERFORMANCE over AVAILABILITY when choosing materials. By using copper and its alloys, brass and bronze, your product is easier to fabricate, better and more durable.

We can get more copper than we now have. Although industry and government have been consuming more copper than in any previous peacetime period, production has kept pace with this increased demand. And producers are not working at full capacity!

More copper keeps on coming. Eleven major new projects in the U. S. will start producing in the next 3 years. These mines will add 250,000 tons to our annual production—more than *¼ of all the domestic copper mined during 1953.* In addition, recent improvements in mining techniques now make it possible to obtain copper from ores considered commercially unworkable in the past.

Copper is virtually indestructible. At least 3 out of every 4 pounds of copper used in today's products, when scrapped, can be re-used in the future. Every day we are adding to our "copper capital". The more copper we use . . . the more we have!

Copper has a new ability to serve you. Many of your problems are being solved in the laboratories of the copper and brass industry. Whether it's a new alloy, a different temper or a special property . . . copper can help you develop new ideas. Copper can bring old methods up to date. Call a supplier of copper and brass and convert your thoughts to action!



* ***"Copper . . . is fortunately available in ample supply to meet any foreseeable demand"***
Foreword, U. S. Dept. of Commerce
B.D.S.A. Copper Quarterly, August 1954

For information about U. S. copper supplies including free copies of this Government report and the new booklet, "Copper . . . Today and Tomorrow", send attached coupon to:

Copper & Brass Research Assn., Dept. SS
420 Lexington Ave., New York 17, N. Y.

NAME .....
COMPANY .....
ADDRESS .....
CITY ..... STATE .....

COPPER & BRASS Research Association

Copper or its alloys provide these advantages . . .

Best conductor of electricity commercially available.

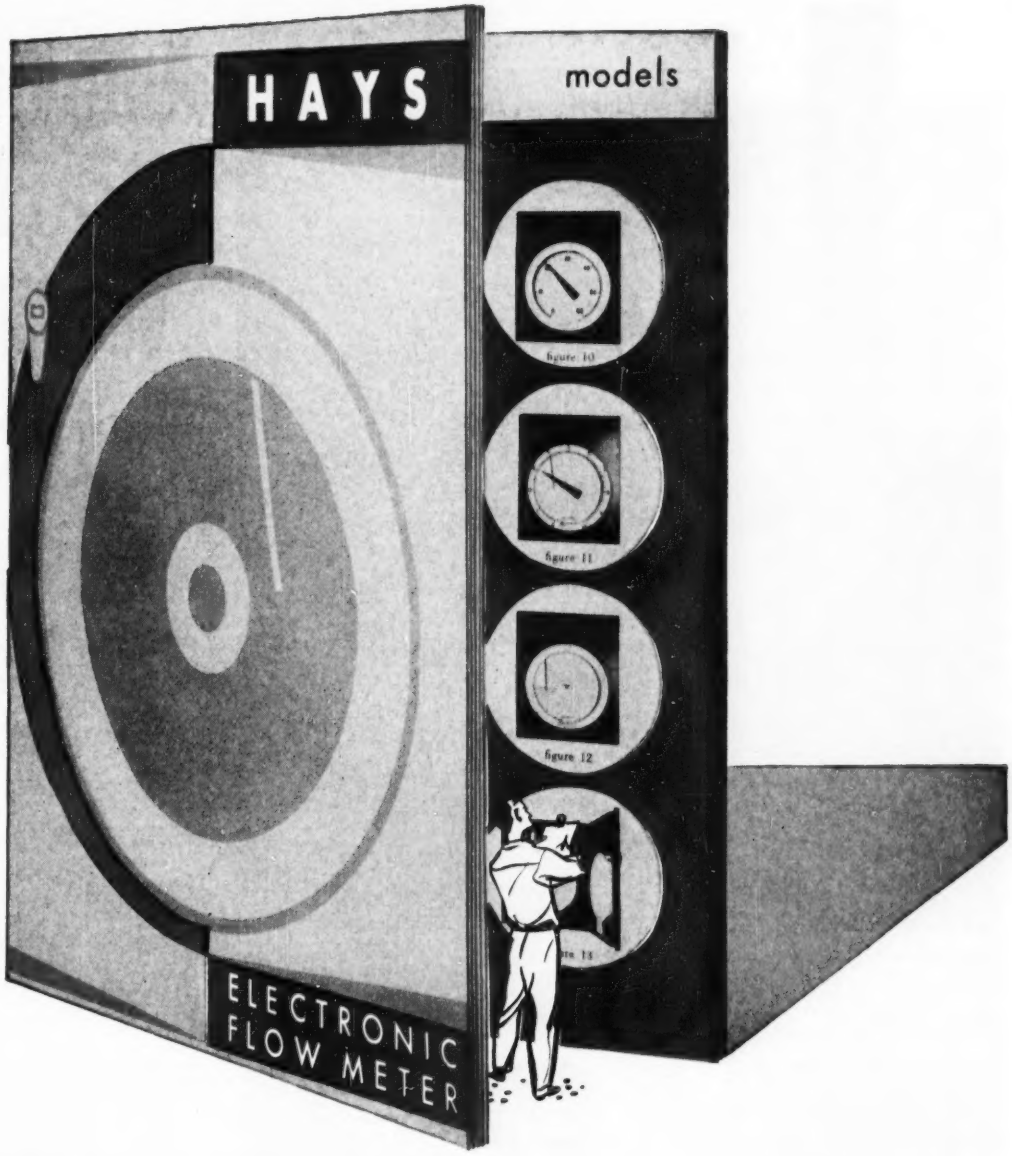
Does not rust . . . high corrosion resistance.

Best heat transfer agent of all commercial metals.

Easy to machine, form, draw, stamp, polish, plate, etc.

Welds readily . . . excellent for soldering and brazing.

For more information circle **38** on inquiry card.



A guide to better flow metering

Here's a new fact-filled, technical booklet that tells you feature for feature how the new Hays electronic flow meter excels.

Electronic operation—provides maximum accuracy (¼% of full scale differential), and speed (4 seconds for full scale pen travel).

Mercuryless transmitters—rupture-proof metallic bellows for differential pressure measurement.

Continuous integration—motor-driven, continuous mechanical integrator is extremely accurate even on rapid load changes.

Other features include powerful motor, easy readability, accuracy unaffected by normal temperature changes, optional explosion and weather-proof transmitter.

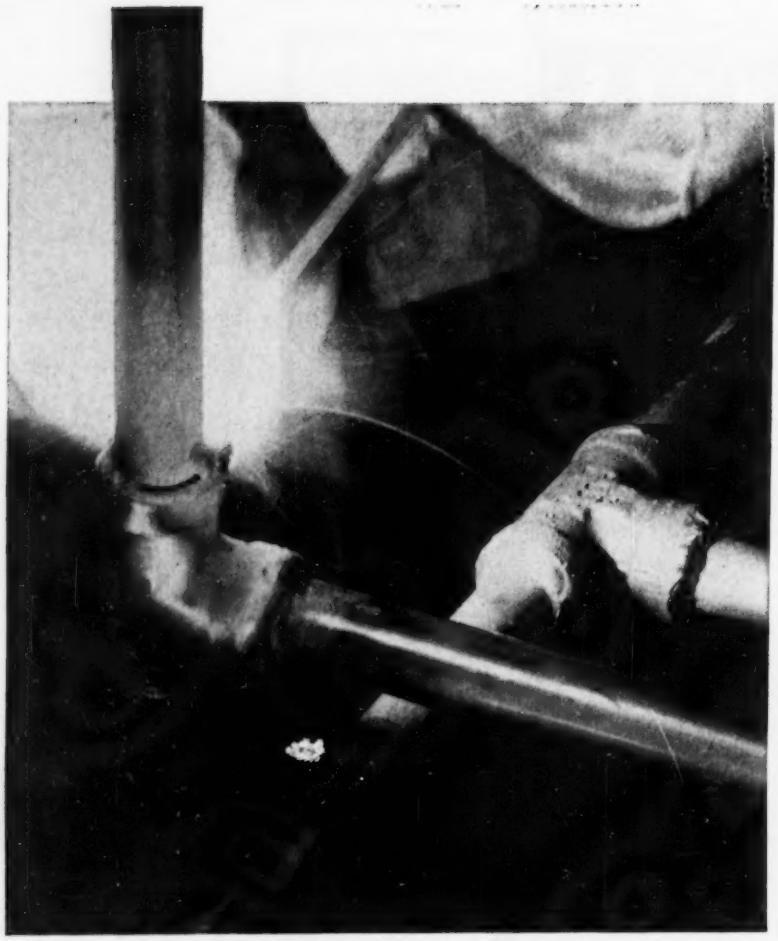
Write for bulletin 54-1074-222 and get the important facts.

Automatic Combustion Control
Boiler Panels • CO_2 Recorders
Veriflow Meters and Verimol
Gas Analyzers • Draft Gages
Combustion Test Sets
Electronic Oxygen Recorders
Electronic Flowmeters
Electronic Feed Water Controls
Miniature Remote Indicators

hays
CORPORATION

Michigan City 8, Indiana

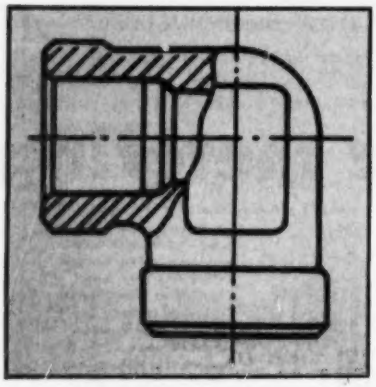
For more information circle **39** on inquiry card.



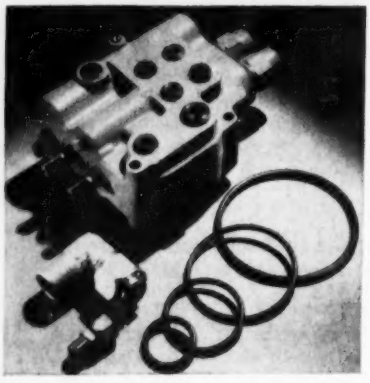
Announcing Parker Weld-lok tube fittings

machined from high-quality steel or stainless steel bar stock and forgings . . . for tubing ¼ through 2 inches O. D.

Simply insert tube; then weld! No wonder Parker's new *Weld-lok* tube fittings are so easy to use . . . for applications involving extreme temperatures, corrosion conditions, or wherever permanently welded joints are needed. With *Weld-lok* fittings, you get permanently tight lines . . . unaffected by vibration, shock, or thermal distortion. They're offered for tubing sizes ¼ through 2 inches O.D.—steel or stainless steel.



Tapered socket of *Weld-lok* fittings aligns and holds tube, while you weld. You don't need special fixtures or equipment to make correctly proportioned weld.



What other Parker products interest you? *Triple-lok* flare tube fittings or *In-tru* flareless tube fittings for instrumentation? Hydraulic control valves? O-rings?

TUBE AND HOSE
FITTINGS DIVISION
Section 410-Q
The Parker Appliance Co.
17325 Euclid Avenue
Cleveland 12, Ohio

Send New Parker *Weld-lok* Catalog No. 4370

Name _____ Title _____

Company _____

Address _____

City _____ State _____

Mail this coupon for your copy of *Weld-lok* Catalog No. 4370. We will also send you the name of your nearest Parker distributor for *Weld-lok* tube fittings.

Parker

Hydraulic and fluid system components

For more information circle **40** on inquiry card.

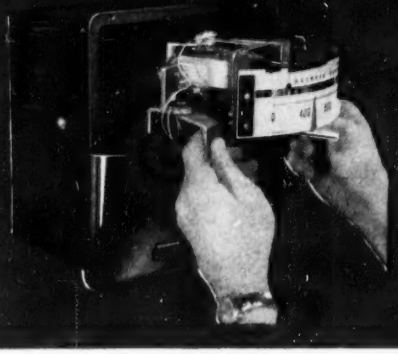
BARBER COLMAN

NEW Wheelco Capacitrol

Offers greater accuracy and dependability . . . choice of SIX control forms!

Here's *instrumentality* at its best! This newly developed Capacitrol offers six different and *new* control forms. On-the-job modifications are easily and quickly made to meet changes in production demands. You merely "plug in" the control chassis you want. Meter movements are "plug-in," too, for faster, easier servicing. Outstanding design features include: *electronic* "no drift" control . . . extra large, calibrated indicating scale . . . manual "droop" correction and proportioning band adjustment . . . integral thermocouple break protection . . . attractive, modern styling . . . and signal lamps to indicate relationship of control temperature to set point. Remarkably low cost. Ask your Wheelco field engineer for details.

FULLY "PLUG-IN" DESIGN
Control chassis and measuring system are easily and quickly removed for inspection or servicing.



SEE IT AT THE INSTRUMENT SHOW IN PHILADELPHIA
VISIT WHEELCO BOOTHS Nos. 453-455

SIX CONTROL CHASSIS ADAPT IT TO A VARIETY OF JOBS:

Model 402—"tru-line," time-proportioning
Model 401—two-position (on-off control)
Model 404—heavy-duty two-position (on-off control)
Model 403—multi-position
Model 405—proportional positioning
Model 407—electric proportioning ("stepless" control)

Write for Bulletin F-6314
Factory-trained field engineers in all principal cities

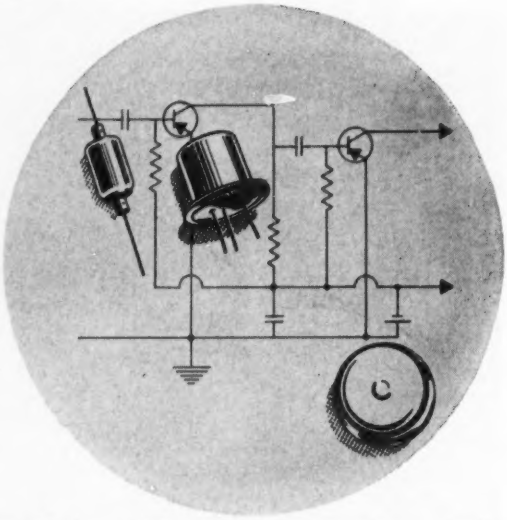
WHEELCO INSTRUMENTS DIVISION
Barber-Colman Company, Dept. I, 1515 Rock St., Rockford, Illinois
Barber-Colman of Canada, Ltd., • Toronto, Ontario
Industrial Instruments • Automatic Controls • Air Distribution Products
Aircraft Controls • Small Motors • Overdoors and Operators • Molded Products • Metal Cutting Tools • Machine Tools • Textile Machinery

For more information circle **41** on inquiry card.

MALLORY

Mercury Batteries Deliver

...Constant Current
...Constant Voltage



.....a necessity for the best performance of transistor circuits

These tiny, Mallory-developed Silverlytic Capacitors are also perfectly suited to the specialized needs of transistor and other low voltage circuits. Write today for information.

Because they are designed especially for transistor circuits, Mallory Mercury Batteries offer the designer of transistor equipment many advantages.

Constant current—constant voltage. Operating either intermittently or continuously, Mallory Batteries provide energy uniformly and dependably. They require no rest periods in order to maintain operating efficiency.

Long shelf life. Even after many months—or even years—of storage, Mallory Batteries maintain their constant output characteristics and give long dependable performance.

For temperature extremes from −65° F to +250° F, Mallory Mercury Batteries have proven their ability to maintain constant potential characteristics.

Highly resistant to humidity and corrosion. Double nickel-plated steel jackets give extra protection to equipment that must operate in corrosive fumes, salt spray or high humidity.

Absolute vacuum or 5000 psi will not affect the operation of Mallory Batteries.

High ratio of energy to size and weight permits miniaturization of electronic equipment.

Leakproof and dimensionally stable. Mallory Batteries will not leak corrosive acids and can be safely used in close fitting receptacles.

If you are designing equipment around transistor circuits, be sure and get complete information on Mallory Mercury Batteries. Our engineers will be glad to work with you in selecting a power supply that will meet your requirements. Technical Bulletin 1-6 will be mailed on request.

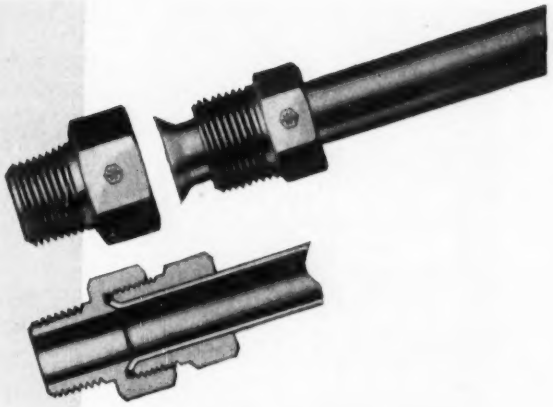
Expect more...
Get more from
MALLORY

Serving Industry with These Products:
Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

For more information circle **42** on inquiry card.

Weatherhead Inverted Fittings Provide Leakproof Connections at Low Cost



BACKED BY THE WORLD'S GREATEST PERFORMANCE RECORD!

Inverted Flare Fittings are a Weatherhead invention backed by a 27-year record of dependable performance. Original equipment on all makes of cars, they assure leakproof and trouble-free connections for any gas, oil, or hydraulic application at any pressure up to 1500 psi. Here are the reasons:

1 **TWO-PIECE DESIGN**—Weatherhead Inverted Fittings consist simply of the body and the tube nut. Once the flare is made, *the right way is the only way* assembly can be made. No sleeve to lose or misapply. Inventory and stocking problems are minimized.

2 **HIGH STRENGTH**—Precision machining from extruded brass stock provides strength equal to forgings and far superior to castings. Built to withstand end pull and bending stresses without leakage. Dry seal pipe threads are standard.

3 **REUSABLE—CUTS COSTS**—Weatherhead Inverted Fittings can be disconnected and reassembled repeatedly without affecting the quality of the joint.

4 **COMPLETE LINE**—Weatherhead's complete line of inverted fittings includes standard nuts, male and female connectors, unions, male and female elbows, tees and adapters.

WHATEVER YOUR NEEDS, you can meet them from the Weatherhead line of brass tube and pipe fittings including: S. A. E. 45° Flare, Compression; S. A. E. 37° Flare, Pipe and Threaded Sleeve connectors. Write for Catalog F-1456. The Weatherhead Company, Dept. M-4, 300 E. 131st St., Cleveland 8, Ohio.

YOU'RE AHEAD WHEN YOU SPECIFY . . .

WEATHERHEAD

This trademark (W) appears on every make of car, truck, bus, and tractor (W) on equipment for machine tools, diesel and hydraulic applications (W) on equipment for instrumentation, oil drilling, mining, road building (W) for aircraft, railway, and marine engines (W) for LP-Gas and anhydrous ammonia control equipment (W) this symbol represents more than 1500 products made by Weatherhead . . .

For more information circle 43 on inquiry card.

PRESSURE...
TEMPERATURE...
DIFFERENTIAL PRESSURE...
FLOW...
LIQUID LEVEL...

AMERICAN-MICROSEN *Electronic* TRANSMITTERS

the modern way to transmit measurements

Advances in process engineering demand modern electronic transmission of measurement signals, particularly when continuous, accurate and instantaneous response is essential.

American-Microsen Electronic Transmitters are ideally suited to the requirements of the modern processing plant and power station. They measure variables at the source — a vital factor wherever inflammable, hazardous, poisonous or corrosive liquids and gases are handled. Such materials are controlled best when closely confined.

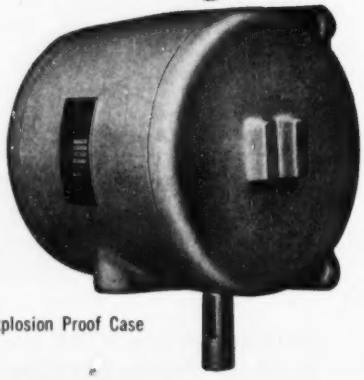
All American-Microsen Electronic Transmitters incorporate the Microsen Balance, a unique electronic "nerve center" with a rectified oscillator output of 0.5 to 5 milliamperes that serves as the accurate transmission signal. Even under severe temperature or supply voltage variations, accuracy within ½ of 1% of scale is obtainable.

The simple, two-wire DC system of American-Microsen Electronic Transmitters eliminates the installation and maintenance cost of pressure piping. And, linear output makes it unnecessary to match transmitters and indicators. The design of all American-Microsen Electronic Transmitters also permits service in relaying and for use with potentiometer receivers.

American-Microsen Electronic Transmitters are ruggedly built for reliable performance under the most severe operating conditions. Get complete information. Write for Catalog 400A.

General Purpose Case

Vapor Proof Case



Explosion Proof Case

AMERICAN
MICROSEN INDUSTRIAL INSTRUMENTS

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONN.

MAKERS OF 'AMERICAN' AND 'AMERICAN-MICROSEN' INDUSTRIAL INSTRUMENTS, 'HANCOCK' VALVES 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, AIRCRAFT PRODUCTS. BUILDERS OF "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

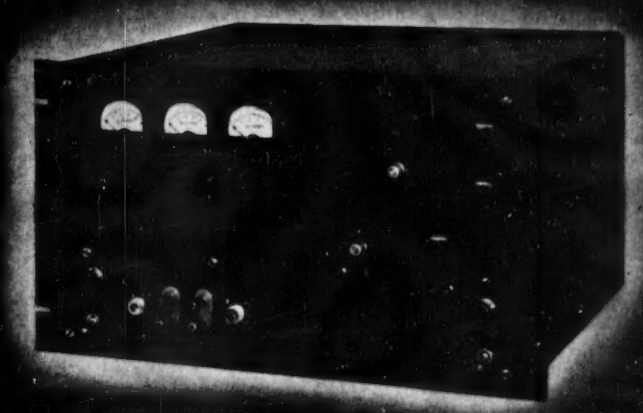
For more information circle **44** on inquiry card.

PRECISION ENGINEERING
CUSTOM MANUFACTURING

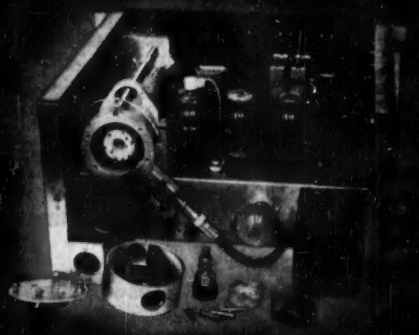
WIDE-RANGE *CONTINUOUS COVERAGE* POWER OSCILLATOR

CONTINUOUS CONTROL WITHIN RANGES
FROM 300 to 900 mc and 900 to 2,500 mc
SEPARATE OUTPUT COUPLING CONTROL

300 to 2500 mc
More than 10w to 1200 mc
More than 2.5w to 2500 mc



$2,285.00
F.O.B. MINEOLA, N.Y.



The 124A Power Oscillator consists of a grid-separation coaxial oscillator employing a 2C39A disc seal triode, an audio oscillator and modulation section, and a self-contained rectifier power supply. A selector switch is provided for the following: internal modulation of 400 or 1,000 cps, cw, or external modulation by pulse or square wave sources. Grid-cathode and grid-plate lines are coupled to a single tuning control, with provision for individual adjustment of the grid-cathode line when desired. Counter-type indicators show the position of the tuning elements. An output coupling control with counter indicator is provided.

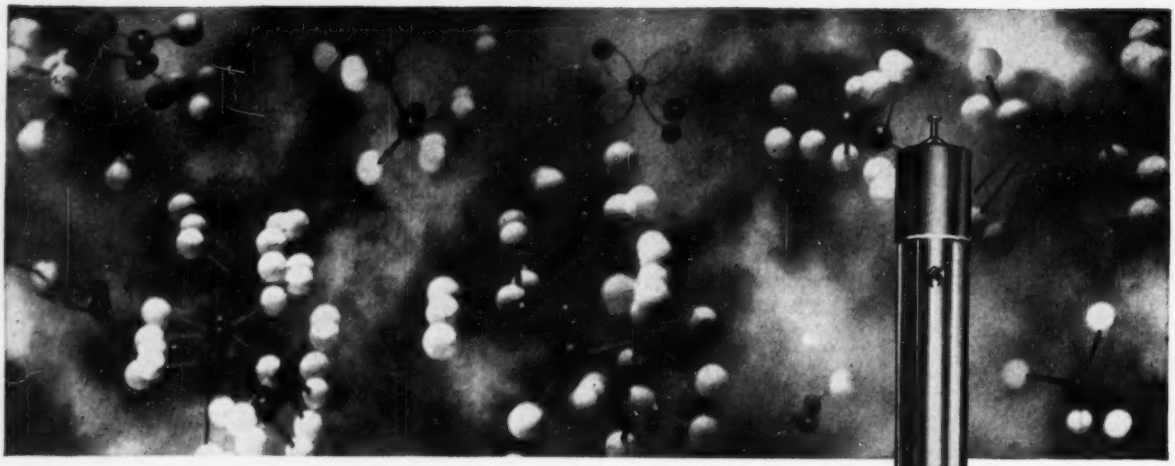
This is one of a series of especially fine instruments and components that have been developed by AIL to meet our own exacting requirements. Our research and development work has demanded equipment not ordinarily available in the electronics market. Thus, we have developed devices that are considerably advanced over those usually available for purchase. Originally we were requested to produce limited quantities for our established clientele. The demand has grown to a point where limited production runs have become necessary. Under these circumstances immediate delivery is often possible.

We suggest that you write at once for specifications and delivery schedules.

Airborne Instruments Laboratory

INCORPORATED

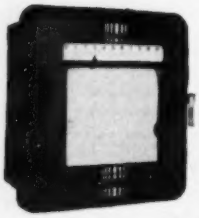
160 OLD COUNTRY ROAD MINEOLA, N.Y.



Spotlight your gas compounds

WITH AN L&N

INFRARED GAS ANALYZER



• Ethylene purity—SO_2 loss—methane build-up—isobutane loss—each is a different gas measurement, in a different process, for different end products. But all are being measured successfully by L&N's Infrared Gas Analyzer, expressly designed for *plant analyses* of gas compounds in multi-component streams.

Typical of the Analyzer's application is measurement of SO_2 in H_2SO_4 stack gas, over the narrow range of 0 to 2% SO_2, with these results—

Stability—0.01% SO_2

Sensitivity—0.005% SO_2

Readability—0.005% SO_2

(Reading taken at 0.2% SO_2)

This highly precise measurement is possible because the Analyzer is engineered by L&N to meet the requirements of actual plant operation.

IT'S ADAPTABLE—You can mount the Analyzer almost anywhere and forget it. Nearby operating equipment—motor driven pumps, compressors, etc., can't affect the measurement either by introduction of stray electrical "hash" or through mechanical vibrations. Such immunities make the Analyzer a "natural" for plant use.

IT'S SIMPLE—The Analyzer has no moving parts—no lenses—no mirrors. It's the only single column gas analyzer built. These features make the Analyzer an uncomplicated, ideally practical addition to your process instrumentation.

The infrared specialists in our Application Investigations Lab will be glad to discuss your use of infrared analysis. You can take advantage of this service, without obligation, by answering the questions on our special Infrared Analysis Data Sheet 600-91-ND46(1) mailed on request.

Or, you can learn more about the Infrared Analyzer and its Speedomax® recorder by requesting Demonstrator ND46-91(1), "How the L&N Infrared Gas Analyzer Works," from Leeds & Northrup Co., 4955 Stenton Ave., Phila. 44, Pa.

LEEDS [LN] **NORTHRUP**

instruments *automatic controls* • *furnaces*

For more information circle **46** on inquiry card.

Editorial...

Instruments and AUTOMATION

Automation

Although several different definitions for the term "automation" have been proposed, the final definition must satisfy the needs of the men using the term, and should include the products scheduled for display at the forthcoming First International Automation Exposition, to be held Nov. 29-Dec. 2 at the 244 Regiment Armory, 14th Street between 6th and 7th Avenues, New York City. The first automation show will answer the questions "what constitutes automation" and "what are the products of the automation field"?

One point brought out in the analysis of "The Automatic Factory" (see pages 1476-1478) is that the "newest" factor in more complete automation of manufacturing operations is the use of electronic computers in the control loop. In recognition of the growing importance of computers in the control picture, the Automation Show is featuring a Computer Clinic, which will offer lectures and demonstrations on various types of computers, digital and analog.

Progressive heads of Instrument Departments, and all others whose duties include control-system analysis or handling of large amounts of data, are urged to avail themselves of this unique opportunity to obtain an over-all view of the applications and operation of the various types of computers available. Forms for advance registration to both the Clinic and the Automation Show can be obtained simply by checking the appropriate squares on the Reader Inquiry cards bound in this issue.

Technological Unemployment

It is strange that the question of technological unemployment is given any serious consideration in this country—where efficient mass production has proved itself to be the foundation for a high standard of living, the highest in the world. But the question keeps coming up, and authorities and editors feel compelled to answer it.

Most answers take the form of "of course not," which, of course, is no answer at all. Indeed, it is not sufficient to point out the past advantages of automatic control, or the past advances in the living standard.

The basic factor is that the economic health of a nation has little to do with its technological development. Depressions can and have happened in all types of societies, advanced and backward societies alike. The economic health of a nation depends on the purchasing power of its populace, and this depends primarily on governmental economic policy (including income-tax rates, federal expenditures, etc., etc.).

Efficient production has NEVER caused unemployment. Unemployment can be caused only by national economic policies that tend to reduce the purchasing power of the consuming public. Let no one try to attribute the results of poor economic policy to those of us who work for efficient production—and let us, conversely, not be misled into thinking that our technical activities determine the economic health of our country.

Research Reactors

The technology of nuclear fission has advanced to the point where all large universities and industrial laboratories must consider the advisability of owning a research reactor, not only to meet immediate problems and developments, but also to retain their prominent positions in research and education.

The readers of *Instruments and Automation* have received, in serial form, the first comprehensive treatment of the subject of research reactors. We are proud to announce the publication and availability of this important series in book form, the first book on this subject in the field—"Nuclear Reactors for Industry and Universities."

The Automatic Factory

In line with our policy of bringing our readers serialized discussions of topics in the news, and now that the serials "Control of Chemical Processes" and "Nuclear Reactors for Industry and Universities" have been concluded, we are pleased to announce the beginning of another important series—"The Automatic Factory—A Critical Evaluation."

This series was written for General Georges F. Doriot in partial fulfillment of the requirements of the manufacturing course at the Harvard Graduate School of Business Administration.

Rimbach Congratulates Japanese Society of Automatic Control

特別寄稿

自　動　制　御

(Automatic Control)

Richard Rimbach*

アメリカでは自動制御の利用により1人1時間当りの工場生産が世界最高の効率を示している。これは"新らしい産業革命"とよぶにふさわしく，1/4 世紀にわたって進歩の一途をたどってきた。

筆者は 1928 年に "INSTRUMENTS-The Magazine of Measurement and Control" を発刊して以来，計装と自動制御の確信を築いてきた。計測と制御の重要であることが一般に認められるよりも前から，26 年の長きにわたってこの方面に奉仕したのである。

この INSTRUMENTS は 1954 年1月から INSTRUMENTS and AUTOMATION と改称された。

筆者は日本の自動制御研究会が "自動制御" を創刊されることにここで祝意を表したい。この発刊は日本よりよくすることにより増すものである。自動制御——オートメーション——の進歩は工業の機械化への創的な第1歩にすぎない。われわれ各機械に自動制御をつけるとか自動制御つきの機械装置類を工場にきとめるという類の考え方をしている間は，工業における自動制御の全能力は発揮されないだろう。工場全体を自動制御の見地から企画するのが当だ。

多分工業全般の概念を一新すべきだろう。機械作業は，一部はすでに高度の半自動式となっており，また工作機械への投資額が他めて高いものではあるが，プロセス工場のプラントにくらべると全然のんまな状態にある。しかし自動工場の構想に実にぴったりとあてはまる新型式の機械が続々と現われつつある。やがては自動車組立工場やトラクタ，自動車，さらに発行機

The first issue (Vol. 1, No. 1) of a new technical publication "Automatic Control," published by the Japanese Society of Automatic Control, featured a congratulatory message from Richard Rimbach who, as publisher of *Instruments and Automation, is well known in Japan.*

The message shown says, in part:

> The writer congratulates the Japanese Society of Automatic Control upon the publication of the first issue of its journal "Automatic Control." The appearance of this first issue is a significant event in the growth and progress of automatic control in Japan.
>
> This expansion of the Japanese technical literature will provide information on automatic control to Japanese engineers and scientists generally. To the extent that the Society of Automatic Control is successful in this endeavor, science, industry and technology will reap the benefit of a wider knowledge and a wider appreciation of the present and potential importance of automatic control.

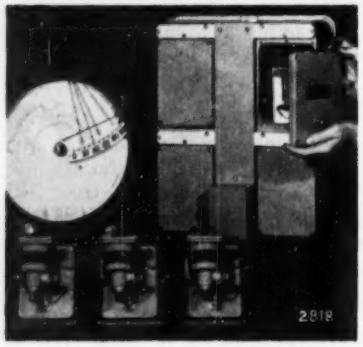
The Month's NEW INSTRUMENTS

In this department we report each month new devices for measurement, inspection, testing, computing, metering and automatic control—in the form of concise technical descriptions.
FOR FURTHER INFORMATION USE THE POSTAGE-FREE ORDER CARD ON PAGE 1509

PROCESS CONTROL

Receiver Recorder

New receiver recorder is said to be the first standard recorder which keeps continuous independent records of one to four pneumatic and electric

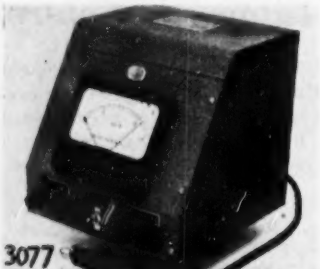


transmissions in any combination. It employs unique plug-in precalibrated receivers as shown in foreground of photo. These units may be added or interchanged. Two plug-in escapement-type integrators may be included in the same casing with two flow records. Fountain-type recording pens provide continuous feed for one year without refilling. Recorder is designed for panel mounting (14x17-in. cut-out). Panel bolt holes and studs are not required—*Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio.*

For more information circle **201** on inquiry card.

Contact-type Controllers

New "Model MR Contact Meter" continuously indicates any electrical variable; provides high or low limit control; can also be used as continu-



ous control with auxiliary equipment. Knob on outside of case provides adjustment of contactor over entire scale range. No magnetic contacts or locking coils are used. Reset can be remote and does not require manual lever or solenoid. Calibrated scales can be furnished for any electrical variable. Controller is portable; is also fur-

CONTENTS OF THIS DEPARTMENT

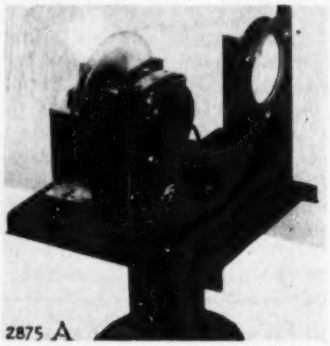
Process Control	1400	Electrical Testing	1423
Temperature	1402	Electrical Instruments	1425
Pressure and Load	1403	Electr.-Instrument Accessories	1428
Speed	1404	Amplifiers	1432
Flow and Volume	1405	Power Supplies	1432
Time and Count	1406	Electrical Components	1433
Computing	1409	Electromechanical Components	1439
Smoke Detection, etc.	1410	Mechanical Components	1449
Liquid Level	1410	Valves	1452
For Laboratory	1411	Miscellaneous	1454
Nucleonics	1412	Aircraft Instr.	1459
Dimensional	1413		
Shop Equipment	1414		
Machine Automation	1416		
Mechanical Testing and Inspection	1418		

nished for wall or panel mounting. It plugs into any standard electrical outlet for immediate operation. ★New "Model MRT Temperature Control Contact Meter" has calibrated temperature scale; operates on output of a standard thermocouple without use of an amplifier.—*Larson Instrument Co., 24 Orchard St., Tarrytown, N. Y.*

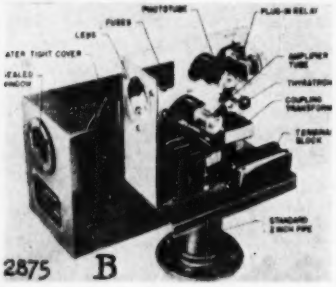
For more information circle **202** on inquiry card.

Photoelectric Controller

New "Modulite" light-beam relay operates on pulsed rather than steady



light. Receiver is tuned only to projector scanning-disk frequency; cannot be triggered by ambient light

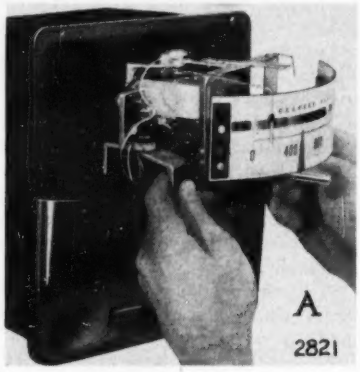


changes or reflections or "fooled" by a flashlight—*Electronic Control Corp., 1573 E. Forest, Detroit, Mich.*

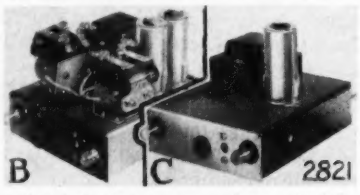
For more information circle **203** on inquiry card.

Indicating Controller

New "400 Series Capacitrol" self-contained direct-deflection indicating controller is available in many control



forms for processes; also for indicating and controlling voltages, current, speed, etc. It utilizes maker's flag-and-



coil frictionless prime-relay principle. Upper section of die-cast case contains plug-in type measuring system and prime relay (Fig. A); lower contains plug-in control chassis: multiposition (Fig. B), stepless proportioning (Fig. C), "anticipatory," etc. Full-view controller window is contoured to eliminate reflection and glare.—*Wheelco Instruments Div., Barber-Colman Co., Rockford, Ill.*

For more information circle **204** on inquiry card.

Automatic Feeder

New "273-F-O-IM6" heavy-capacity automatic weigh-feeder for use on plastic injection molding machines of 50- to 100-oz. capacities has a 6¾-lb. capacity weigh bucket and a 350-lb. capacity hopper. Scale unit is maker's "Over-and-Under Model 273" industrial scale.—*Exact Weight Scale Co., 944 W. Fifth Ave., Columbus, Ohio.*

For more information circle **205** on inquiry card.

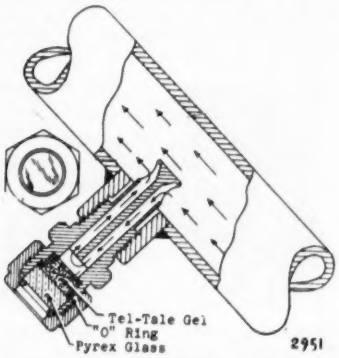
Gas Analyzer-recorders

New panel-type instruments for plant stream and laboratory monitor various mixtures and trace impurities such as: 99.5 to 100 percent argon 0.005 percent; and 99.0 to 100 percent oxygen 0.01 percent. Panels are complete, ready to install, include "Electronik" recorder, flow regulators and meters, drying towers, special VR-power pack with regulated d-c. output and a "Super-Recorder" 8 T/C cell for sensitive service in a thermostatted cabinet.—*Gow-Mac Instrument Co., 100 Kings Rd., Madison, N. J.*

For more information circle **206** on inquiry card.

Gas-stream Hygroscope

New "Little One Eye," for installation in gas lines, instantly indicates relative humidity of stream by color



change of "Tel-Tale" silica gel. Available as "Model 38" (shown), "Model 38S" without Venturi, and "Model T-50" in ½-in. tubing tee.—*Pilotrol Corp., P. O. Box 172, Springfield, N. J.*

For more information circle **207** on inquiry card.

Continuous Polymerization Control Panel

New centralized system for controlling continuous polymerization reactors provides automatic flow control of raw material, catalyst and product streams; also control of reaction temperatures; uses 23 air-operated flow controls; provides (1) precise proportioning of feed streams, (2) centralized control of all process pumps, (3) independent and automatic control of catalyst feed, and (4) integral operations monitor and warning system. Process capacity is regulated by adjustment of one handwheel: to vary pumping rate in process streams while keeping preset

Makes Precision Light Measurements Quickly-Accurately

Welch DENSICHRON ®

ELECTRONIC Ddensitometer

For

- PHOTOMICROGRAPHY
- REFLECTOMETRY
- MICRODENSITOMETRY
- COLORIMETRY

Booth No. 1125
I.S.A. Congress and Exposition
Philadelphia, Pa.
Sept. 13-24

The Welch Densichron is an electronic densitometer of good sensitivity and unusually high stability. It can be employed either for quantitative measurement of optical density, or as a sensing device for automatic control of various industrial processes in which constancy of transmitted or reflected light is a criterion of the quality or uniformity of the product.

It consists essentially of a probe unit containing a photoelectric tube for detecting light energy and an amplifier to which it is connected by a flexible cable. The amplifier incorporates a milliammeter calibrated to indicate either optical density on a "log" scale or percent transmission on a "linear" scale, depending upon the model.

Although the Densichron can be used in a wide variety of ways it is a simple device to use and requires no special operator skill. It will perform satisfactorily in routine operations for long periods of time with little or no servicing, yet is readily adaptable to innumerable types of special measuring techniques.

The DENSICHRON is supplied complete with a blue-sensitive light probe (or red if specified), five measuring apertures, a cone with ⅛ inch aperture, and metal support for the probe unit. The current consumption is 30 watts. For operation on 115 volts—60 cycle AC only.

WRITE FOR 12-PAGE BOOKLET GIVING OPERATION CURVES, RESULTS OF LABORATORY TESTS AND OTHER VALUABLE INFORMATION.

EACH
$225.00

Reflection Unit Accessory with Voltage Regulated Transformer—$135.00.

Manufacturers of Scientific Instruments and Laboratory Apparatus

W. M. WELCH SCIENTIFIC COMPANY
DIVISION OF W. M. WELCH MANUFACTURING COMPANY
ESTABLISHED 1880
1515 Sedgwick St., Dept. S, Chicago 10, Illinois, U.S.A.

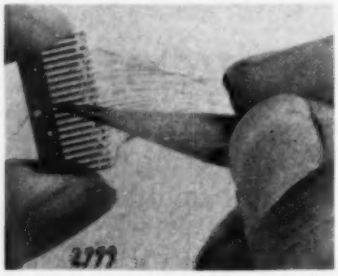
For more information circle **47** on inquiry card.

proportions. In addition, any process pump can be cut out by throwing a switch.—*Milton Roy Co., Station V, 1300 E. Mermaid Lane, Philadelphia 18, Pa.*

For more information circle **208** on inquiry card.

Infrared Photocells

New "Ektron Detectors" are photoconductive lead-sulphide cells with sensitivity to infrared said to be



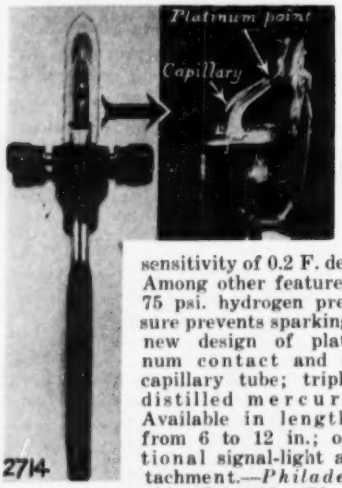
"10,000 times as much . . . as previous laboratory instruments." Although peak sensitivity is in near-infrared, detector is highly sensitive to visible and ultraviolet light. Applications include infrared spectrometry, automatic switching, monitoring, etc. Multiple arrays of 20 or more detectors can be assembled on less than one inch of glass to obtain response to patterns of light or heat.—*Eastman Kodak Co., Rochester 4, N. Y.*

For more information circle **209** on inquiry card.

TEMPERATURE

Thermoregulator

New "Quick-Set" can be adjusted "with the flick of your finger" from room temperature to 550 F. with



sensitivity of 0.2 F. deg. Among other features: 75 psi. hydrogen pressure prevents sparking; new design of platinum contact and of capillary tube; triple-distilled mercury. Available in lengths from 6 to 12 in.; optional signal-light attachment.—*Philadelphia Scientific Glass Co., 4 Eckard Ave., Abington, Penna.*

For more information circle **210** on inquiry card.

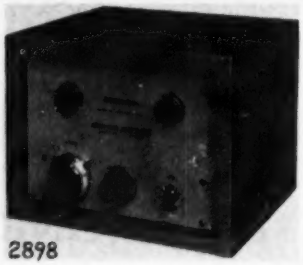
Thermoscopic Sticks

New "Tempilstiks" for 463 and 488 F. supplement the 413 and 438 F. "Tempilstiks" announced about two months ago.—*Tempil Corp., 132 W. 22nd St., New York 11, N. Y.*

For more information circle **211** on inquiry card.

Temperature Controller

New "Hallikainen-Shell Development Resistotrol Temperature Controller," for use where precision control is required, employs resistance



type bulb suitable for temperatures up to 600 F. Instrument is an a-c. bridge type, providing sensitivity (exclusive of bulb) of 0.005 F. Bulbs available for pressure vessels, baths, ovens, etc. Standard bulb has 4-sec. response; faster bulbs or thermistors available.—*Hallikainen Instruments, 1341 Seventh St., Berkeley, Calif.*

For more information circle **212** on inquiry card.

Wax-fill Thermostat

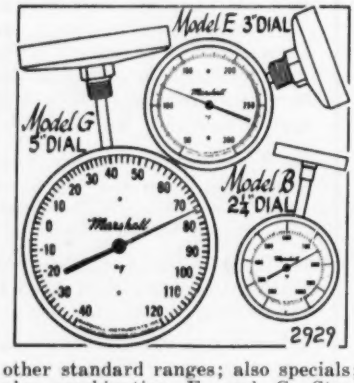
New "Power-Pill" thermostat is actuated by a compact thermal unit charged with a wax-like composition instead of conventional gases or vol-

atile liquids. Wax compound melts as water in controlled system begins to heat up and solidifies again upon cooling: volumetric increase on melting serves to actuate thermostat valve. New "Power-Pill" element is said to be "admirably suited for operation in pressurized systems."—*Fulton Sylphon Div., Robertshaw-Fulton Controls Co., Box 400, Knoxville, Tenn.*

For more information circle **213** on inquiry card.

Dial Thermometers

New dial thermometers in sizes shown are available for immediate delivery in –40 to 120 F. range; nine



other standard ranges; also specials; also combination F. and C. Stem lengths from 3 to 84 in.; accuracy 1 percent of full-scale.—*Marshall Instruments, Inc., 7333 Coldwater Canyon Ave., N. Hollywood, Calif.*

For more information circle **214** on inquiry card.

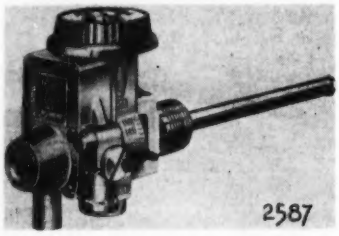
Clinical Thermometer

New "Swiftem" is said to be the first advance in clinical thermometry since before 1900. A small tapered stainless steel tube, applied to patient as if it were conventional glass bulb, has in its tip a 0.03-in. diam. by 0.03-in. long thermistor. Indicating instrument is about the size of a photographic exposure meter. A push button in side of case is pressed to take a reading. Features of systems are speed of 3 to 5 sec. (instead of 3 min.) to obtain a reading, higher accuracy than mercury thermometer; no breakage; sterilized in conventional manner; luminous dial.—*Burlington Instrument Co., Burlington, Iowa.*

For more information circle **215** on inquiry card.

Water-heater Controller

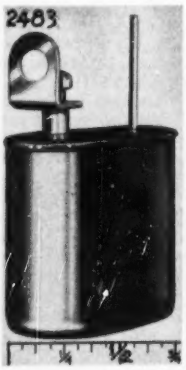
New "Model 102 Unitrol" gas water heater control is suitable for all gases, including L.P.; comprises a thermomagnetic automatic pilot unit, a snap



action thermostat, and a large capacity gascock. Special aluminum alloys for all close-fitting parts exposed to gas; corrosion-resistant red brass and copper for parts immersed in water. *Robertshaw-Fulton Controls Co., Greensburg, Penna.*

For more information circle **216** on inquiry card.

Miniature Thermostat



New "Model 21 Hermetically Sealed Miniature Thermostat" controls non-inductive loads up to 5 amps. at 27.5 v.dc., features rapid response. Exposure to temperatures between –100 F. and 300 F. does not alter original calibration. Units are shipped precalibrated to specified operating degree and sealed. Non-calibrated units available. Terminal and mounting arrangements can be furnished from stock to meet requirements. One terminal is grounded to case.—*George Ulanet Co., 416 Market St., Newark 5, N. J.*

For more information circle **217** on inquiry card.

Thermocouple Gland

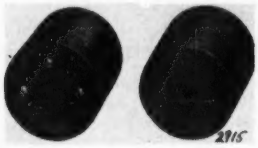
New "Model TG-14-T" provides corrosion-resistance of Teflon in a fast-responding thermocouple (average characteristic time 4.5 seconds) for pressures up to 5000 psi. at temperatures from –90 F. to 500 F. 18-gage TC wires, either iron-constantan or copper-constantan, are available.—*Conax Corp., 4515 Main St., Buffalo 21, N. Y.*

For more information circle **218** on inquiry card.

PRESSURE and LOAD

Pressure Pickup

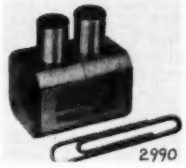
New "Model 408 Absolute Pressure Potentiometer," capable of withstanding 50-*G* longitudinal acceleration



with less than 1 percent error, is designed for aircraft, missile and industrial applications. An evacuated aneroid-type bellows provides reference absolute pressure. Weight 7 oz.; rating ½-watt at 160 F.—*Bourns Laboratories, 6135 Magnolia Ave., Riverside, Calif.*

For more information circle **219** on inquiry card.

Pressure Pickup

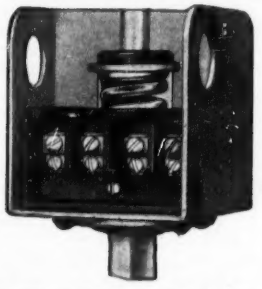


New "Model S-3" operates on variable-reluctance principle and is suitable for use with various recording and telemetering systems. Output signal proportional to input pressure. Especially suited for transient and high-frequency pressure measurements; also many static and slow-response applications. One specialized use is transient differential pressures.—*Ultradyne Engineering Labs, Inc., P.O. Box 8007, Albuquerque, New Mexico.*

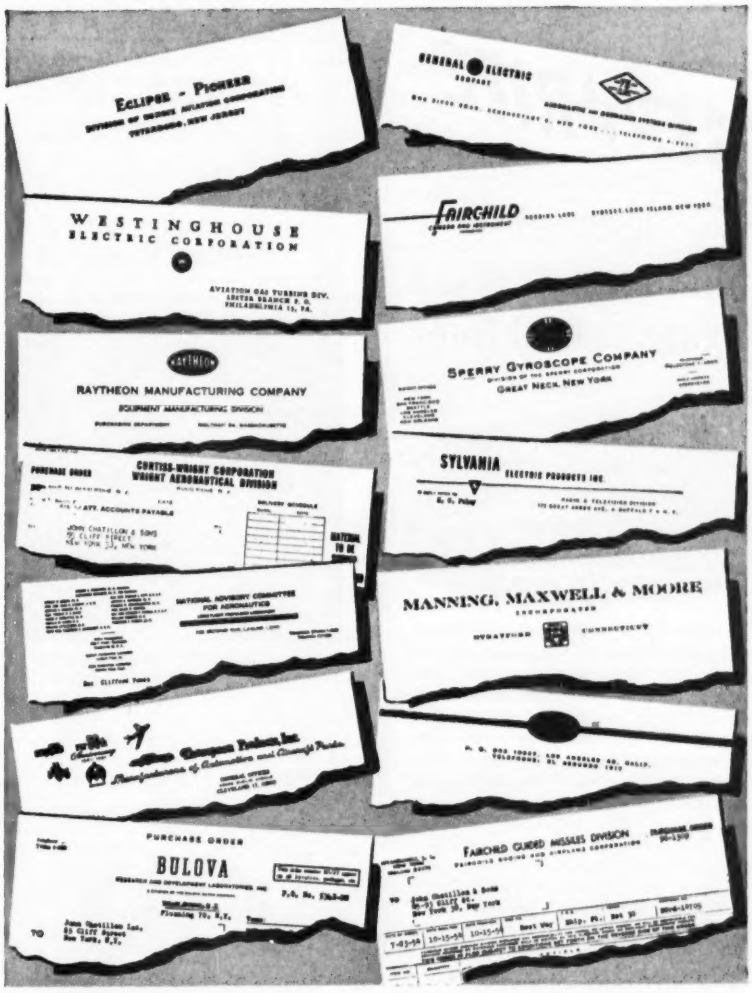
For more information circle **220** on inquiry card.

Pressure Switch

New "Bulletin 10007" is designed specifically for heavy-duty long-service applications: air compressors, do-



mestic water pumps over 1 hp., etc. All parts with bearing surfaces are stainless steel. Diaphragm is said to be "practically indestructible." Silver alloy contacts never need filing or cleaning. "Straight through" wiring



These letters and orders speak for themselves about

CHATILLON ISO-ELASTIC* SPRINGS

Every day brings added proof of increased accuracy achieved in spring operated instruments of every type designed or redesigned to utilize temperature-compensated Iso-Elastic Springs. Names like Bendix (Eclipse-Pioneer), Curtiss-Wright, Fairchild Camera, General Electric, Sperry Gyroscope add up to an impressive case for Iso-Elastic!

Chatillon Iso-Elastic alloy, developed by Chatillon in conjunction with Professors A. V. de Forest of M. I. T. and F. Sayre of Union College, is virtually unaffected by shifts in temperature. This remarkable material eliminates errors resulting from drift and hysteresis, maintaining constant strength and elasticity from −50° to 150° F!

Whether you are in the aircraft, instrument or electronics field, Chatillon guarantees this: That your products will gain in accuracy and efficiency as a result of Chatillon's unparalleled spring design "know how". Contact our Spring Division or write for Engineering Bulletins on Chatillon Iso-Elastic springs.

***U. S. A. Pat. No. 2174171**

JOHN CHATILLON & SONS

85 CLIFF STREET, NEW YORK, N. Y.

Manufacturer of Precision Springs and Measuring Apparatus Since 1835

For more information circle **48** on inquiry card.

"SERV-RITE"

Insulated Thermocouple Wire Extension Lead Wire

FOR

PLATINUM COUPLES
CHROMEL ALUMEL
IRON CONSTANTAN
COPPER CONSTANTAN
IRON CUPRONEL

No matter what your wire or insulation requirements may be, you can depend on Gordon "Serv-Rite" insulated wire for pyrometers—recognized as a standard of highest quality for nearly half a century. All "Serv-Rite" wire is now manufactured in the new, completely modern Gordon plant, employing up-to-date equipment and machinery, supervised and operated by skilled technicians—your guarantee of continued precision quality. In addition to maintaining large stocks of all common types of wire, Gordon will manufacture special insulation, in long or short runs, to suit your individual needs and meet your most rigid specifications.

All Types of Insulation

Felted Asbestos
Asbestos Braid
Weatherproof Braid
Glass Braid
Polyvinyl Plastic
Nylon Braid
Stainless Steel Armored Braid
Silicone Treated
Cotton Braid
Lead Jacket

The home of "SERV-RITE"

Full Particulars on Request

4229

GORDON SERVICE

CLAUD S. GORDON CO.

Manufacturers & Distributors

Thermocouple Supplies • Industrial Furnaces & Ovens
Pyrometers & Controls • Metallurgical Testing Machines

Dept. 21 • 3000 South Wallace St., Chicago 16, Ill.
Dept. 21 • 2035 Hamilton Ave., Cleveland 14, Ohio

For more information circle **49** on inquiry card.

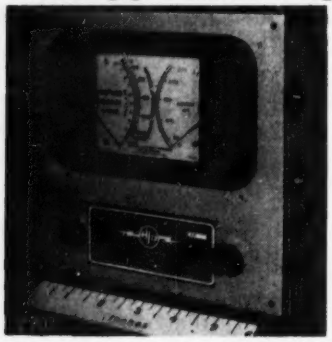
NEW INSTRUMENTS

for ½ or ¾-in. conduit. Operating range and differential set at factory according to users' specs but range can be adjusted with screwdriver and differential with a small wrench.—*Cutler-Hammer, Inc.*, 256 12*th St., Milwaukee* 1, *Wis.*

For more information circle **221** on inquiry card.

Vacuum Gage

New panel-mounted model of maker's vacuum gage is announced. Gage

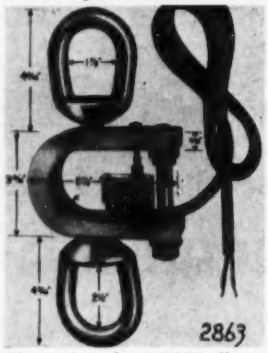


is for instantaneous measurements of vacuums in 1-to-1000 microns Hg range.—*Hastings Instrument Co., Warwick, Va.*

For more information circle **222** on inquiry card.

Load Switch

Two new safety features incorporated in "Dyna-Switch": Free-riding stop bolt at open end of U-bar allows



deflection of only 11,000 lbs. while permitting accidental overloads up to 35,000 lbs. with safety and without injury to calibration.—*W. C. Dillon & Co., Inc., P. O. Box* 3008, *Van Nuys, Calif.*

For more information circle **223** on inquiry card.

SPEED

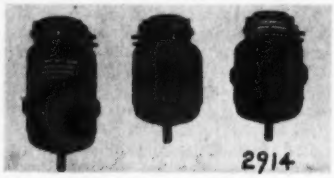
Motor Speed Controller

New "Electronic Speed Control" is free from radiation interference. Continuous life in excess of 100,000 hours when operated under normal conditions; incorporates full-wave selenium rectifiers; provides full rated motor torque with speed ratios in excess of 25 to 1; contains no tubes; is available with dynamic braking and instantaneous reverse, also in multiple units. *Erdco Engineering Corp., Addison, Illinois.*

For more information circle **224** on inquiry card.

Tachometer Generators

New "Comspec" line permanent-magnet d-c. tachometer generators are similar in essentials to maker's

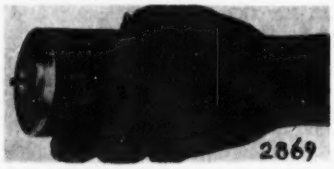


units being built to MIL specs but priced at a level said to make them "attractive for high-quality commercial applications." Two sizes, three frames. Speed range 50 to 5000 rpm. —*Instrument Motors, Box* 5, *Stamford, Conn.*

For more information circle **225** on inquiry card.

Tachometric M-G

New "Type MG-8-675-45" miniature a-c. motor-driven induction generator combines an induction motor having a high torque-to-inertia ratio with a

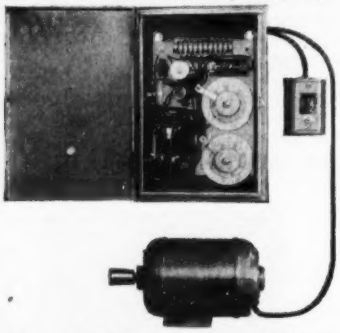


linear drag-cup generator, positively aligned in a single housing. When one generator phase is excited, other phase develops an output voltage proportional to speed; frequency is same as that used to excite unit. Linearity depends on voltage output desired and range of operating speeds.—*Electric Indicator Company, Inc., Springdale, Conn.*

For more information circle **226** on inquiry card.

Motor Speed Controllers

New "Bulletin 6520 Vari-Amp" magnetic-amplifier motor drive provides adjustable motor speeds; con-



verts a-c. power from a 115-v.ac. source to d-c. power to drive a d-c. motor. Speed is continuously adjustable over complete range. Standard unit speed range 10-to-1 available with motors from 1/40 hp. to ½ hp. Optional features include jogging, dynamic braking and reversing. System employs a full-wave self-saturating magnetic amplifier unit containing no tubes or moving parts. No warm-up period.—*Clark Controller Co.*, 1146 *E.* 152*nd St., Cleveland, Ohio.*

For more information circle **227** on inquiry card.

Stroboscope

New "Model A-44" hi-fi stroboscope and disk has numerous industrial applications in high-precision meas-

urements of rotational speeds. Germanium diode provides exceptionally clear pulses of light: 0.1-millisec. flash and better than 50 percent peak intensity. Operates on 115 or 220 v.ac., 50 or 60 cps.—*Sela Electronics Co., 128 W. 48th St., New York 36, N. Y.*

For more information circle **228** on inquiry card.

FLOW and VOLUME

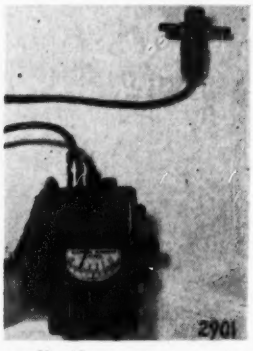
Wind Pickup

New pickup enables wind's force and direction to be measured electrically. Feature is said to be instantaneous response to sudden changes or shock waves. Deflection of light-weight 2-in. diam. hollow metal ball is extremely small at highest wind force for which it was designed. Unit is essentially a cylindrical cantilever beam on which there are two independent Wheatstone bridge circuits consisting of SR-4 resistance wire strain gages arranged to measure strains caused by wind forces in two directions at right angles to each other. Combination of these bending strains provides a means of indicating flow-rate and direction. Principle is applicable for use in water or other liquids.—*Baldwin-Lima-Hamilton Corporation, Philadelphia 42, Pa.*

For more information circle **229** on inquiry card.

Electrothermal Flowmeter

New "Electronic Flowmeter" weighs 27 oz.; directly indicates gas flow-rate in 50 to 10,000 cc./min. range for



such applications as process control and quick line checks. Directly-heated thermocouple gage tube can be placed in line for low flow rates with prac-

Meet the Widest Range of flow measurement requirements with AMERICAN-WESTCOTT A-88 ORIFICE METERS

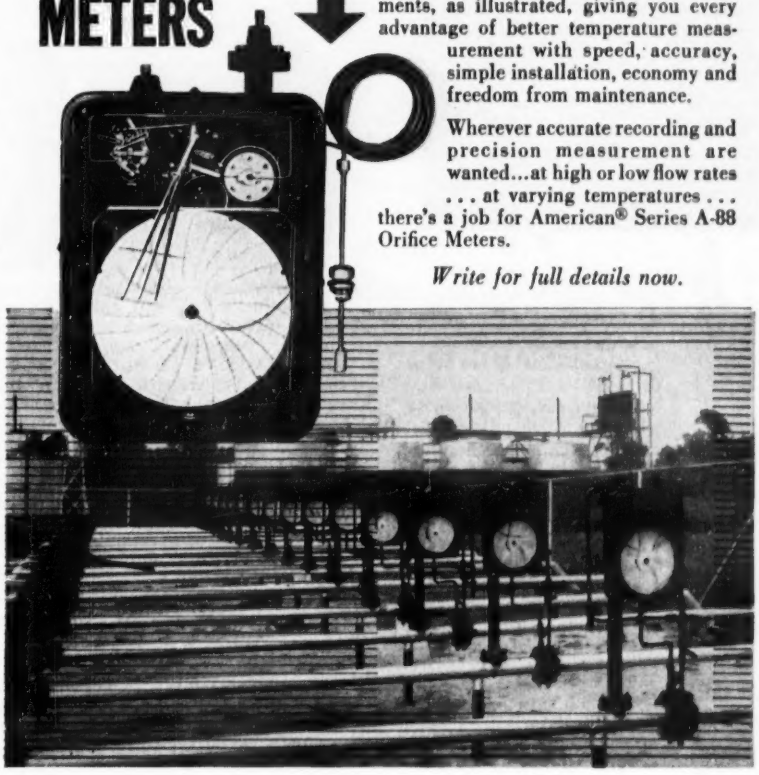
RECORDING · INDICATING
INTEGRATING · TELEMETERING

American A-88 standard mercury type orifice meters for working pressures to 5000 psi. in interchangeable 10, 20, 50, 100 and 200-inch ranges give you complete versatility to meet any flow measurement requirement. Integrating instruments integrate both static and differential pressures giving totalized flow indications and telemetering equipped instruments transmit integrated indications to remote locations.

Recording Meters may be equipped with standard O-150°F. Temperature Elements, as illustrated, giving you every advantage of better temperature measurement with speed, accuracy, simple installation, economy and freedom from maintenance.

Wherever accurate recording and precision measurement are wanted...at high or low flow rates ... at varying temperatures ... there's a job for American® Series A-88 Orifice Meters.

Write for full details now.



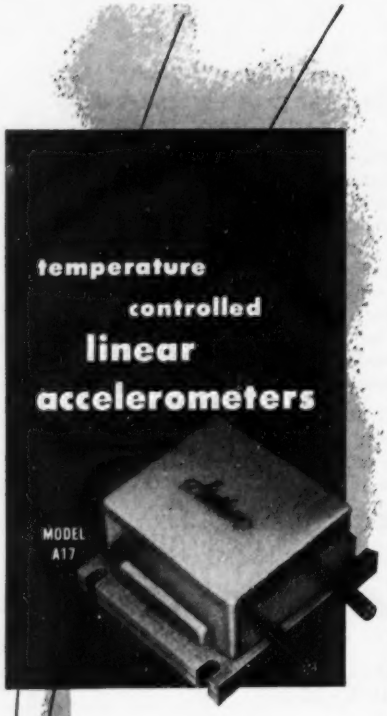
AMERICAN-WESTCOTT MERCURY MANOMETERS GIVE YOU ALL THESE ADVANCED DESIGN FEATURES . . . . . .

- Minimum Simple Maintenance—easy access to float lever arm during calibration.
- Highest Accuracy—inherent straight line calibration.
- Interchangeable Ranges—no manifold piping changes.
- Pressure-Tight Teflon-Packed Stuffing Box—nearly frictionless, free from maintenance troubles, never needs lubrication.
- Teflon-Packed Pulsation Dampener—externally adjustable under full line pressure without leakage.
- Dependable Performance—improved check valves give positive shut-off for over-range protection.

AMERICAN® METER COMPANY

GENERAL SALES OFFICE: 1513 Race Street, Philadelphia
Albany • Alhambra • Atlanta • Baltimore • Birmingham
Boston • Chicago • Dallas • Denver • Erie • Houston
Kansas City • Los Angeles • Minneapolis • New York
Omaha • Pittsburgh • San Francisco • Seattle • Tulsa
IN CANADA: Canadian Meter Company, Limited, Hamilton
Edmonton • Calgary

For more information circle **50** on inquiry card.



The usefulness of Statham unbonded resistance strain gage accelerometers has been further extended by special temperature control packaging which ensures that dynamic as well as static characteristics remain constant despite temperature variations such as are encountered in flight applications.

Operation through the ambient temperature range −65° F. to +120° F. is afforded by means of an electrical heater jacket with a peak power input of approximately 20 to 30 watts.

Depicted is the Model A17 accelerometer which is offered in ranges from ±1g to ±15g. Other temperature controlled models cover ranges from ±0.5g to ±15g.

Please request Catalog Bulletin No. AT-1.

Statham LABORATORIES, INC.

12401 W. Olympic Blvd. • Los Angeles 64, Calif.

For more information circle **51** on inquiry card.

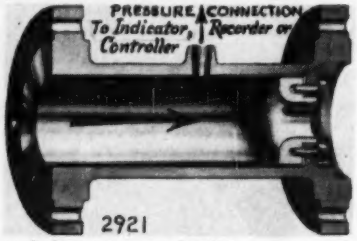
NEW INSTRUMENTS

tically no pressure drop in line; can be used with long extension cables for remote indications. Logarithmic calibration provides ease of reading in low flow ranges. Response time ½ second. Accuracy 2 percent. Instrument may also be calibrated for measurement of mass flow in pounds of air or gas.—*Hico Instruments Div., Hastings Instrument Co., Warwick, Va.*

For more information circle **230** on inquiry card.

Critical-flow-principle Gas-flowmeter Element

New "Critiflo-Meter" operates on principle successfully employed for decades in critical-flow provers used for high-accuracy checks of gas meters. Principle: when any gas passes through a round-edge orifice



and downstream absolute pressure is less than half upstream absolute pressure (exact ratio depends on various factors), velocity of each particle of gas at upstream pressure will attain sonic velocity. Thus, if upstream temperature and gas (or steam) composition remain constant, upstream absolute pressure will be exactly proportional to mass flow-rate. Flow indicator, recorder or controller can be of ordinary gage-pressure (instead of differential-pressure) type. Costs of installation and maintenance are said to be "outstandingly low."—*King Engineering Corp., Ann Arbor, Mich.*

For more information circle **231** on inquiry card.

Hot Wire Anemometer

New "Model HWB" is an improved hot-wire anemometer of constant-current type for measurement of average velocity, large velocity fluctuations and turbulence in fluid flow. Wide selection of hot-wire probes for industrial and laboratory applications. Accuracy, sensitivity, and band-width are said to "surpass any laboratory or commercial anemometer reported to date."—*Flow Corp., 283 Concord Ave., Cambridge, Mass.*

For more information circle **232** on inquiry card.

TIME and COUNT Electric Counters

New "Sodeco" electric counters with instantaneous (0.4-sec.) electrical reset are available in 4- or 5-digit models. Standard models have counting speeds to 10 impulses/sec; specials to 25 impulses/sec. If necessary, reset voltage may be different from impulse voltage. Counters are available with or without housings.—*Landis & Gyr, 45 W. 45th St., New York 36, N. Y.*

For more information circle **233** on inquiry card.

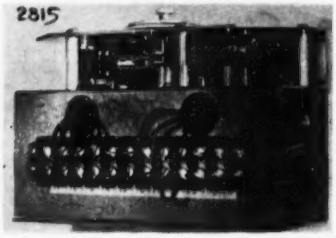
24-hour Time Switch

New multiple-operation time switch features easy adjustment for complete 24-hour schedules by sliding self-contained non-removable trip levers in or out on a dial scaled in 15-minute graduations. As many as 48 "on" and 48 "off" operations for every 24-hour period. Two models: with or without calendar device to cutout non-working days. Capacity 1000 watts.—*Zenith Electric Co., Dept. IUP, 152 W. Walton St., Chicago 10, Ill.*

For more information circle **234** on inquiry card.

Automatic Timer

New "Motorelay" provides two separate timing circuits for start and stop cycles that operate independent of each other irrespective of auto-

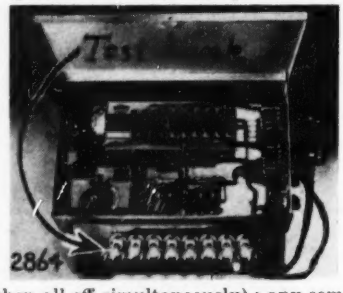


matic reset. It is normally field adjustable over a range of 20 to 165 seconds for both "start" and "stop" time delay. (Periods up to 10 min. also available.) Unit comprises continuously-running synchronous motor, reduction gearing, solenoid-operated clutch controlled by pilot circuit, camshaft with adjustable cam for each circuit, and load relay commanded by two cam-actuated switches.—*Automatic Control Co., 995 University Ave., St. Paul 4, Minn.*

For more information circle **235** on inquiry card.

Multiple-sequence Timer

New "Magic Box" provides any "chaser" action (instantaneous switching from one circuit to next); any "speller" action (build-up till all on,

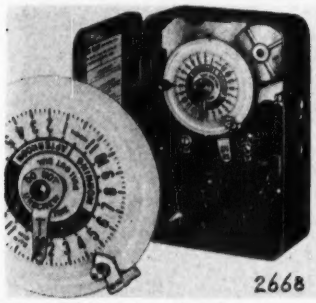


then all off simultaneously); any combination of "chaser" and "speller." Number of loads, 17, each adjustable from 1/5 sec. to over 20 sec.; up to 400 watts per point.—*Gale Dorothea Mechanisms, 81-01 Broadway, Elmhurst, L. I., N. Y.*

For more information circle **236** on inquiry card.

Time Switches

New "Inter-Matic" time switches feature "E-Z See" dial: black on yellow (best color combination under all

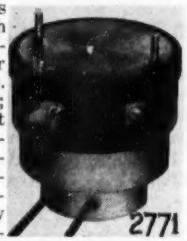


light conditions); also larger, more clearly defined numerals.—*International Register Co., 2624 W. Washington Blvd., Chicago 12, Ill.*

For more information circle **237** on inquiry card.

Automatic Timer

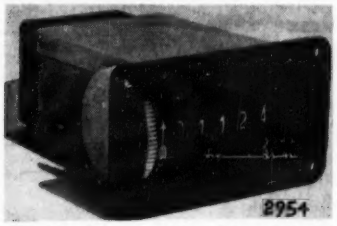
New "Series PB" timer with "Circle B" synchronous motor is rated 25 amp. at 115 v. 60 cps.; has dust-tight housing; operates in any position; has quick-connect terminals, heavy-duty solid-silver contacts, nylon cam, latch and operating button.—*Bristol Motor Div., Vocaline Co. of America, Inc., Old Saybrook, Conn.*



For more information circle **238** on inquiry card.

Electric Counter

New "Model F-106" (German-made) is designed for panel mounting; features speed of 1200/min.; is

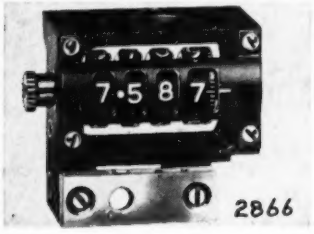


available for operation from 6 to 200 v. a.c. or d.c. One turn of knob resets to zero.—*Presin Co., 5225 Wilshire Blvd., Los Angeles 36, Calif.*

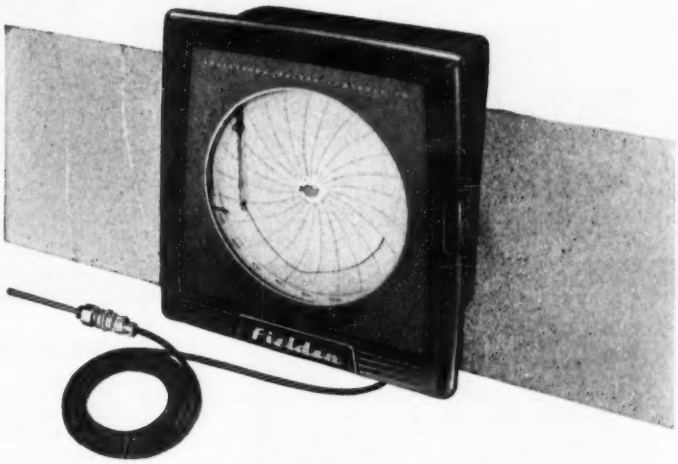
For more information circle **239** on inquiry card.

Goniometer Counter

New "High Speed "Y" Productimeter" is designed especially for manufacturers of navigating and di-



can you really buy high accuracy at low cost?



of course you can! This new Fielden Resistance Thermometer Recorder, for instance, measures temperatures up to 950°F. with an inherent accuracy of ±0.5% of full scale! But it sets a new price standard because . . .

. . . we've eliminated the usual design complexities. For example, this self-balancing type recorder uses an AC-actuated bridge circuit that eliminates direct current source and replacement of dry cells. An interchangeable measuring unit permits change in range or measurement without re-wiring. The complete recorder is assembled from only 5 easily replaceable and interchangeable sub-units.

This is Fielden simplified instrumentation—all the accuracy you can possibly use—at an economical price. Mail the coupon for full details.

DOLLAR FOR DOLLAR—YOUR BEST INSTRUMENT VALUE

Robertshaw-Fulton

CONTROLS COMPANY

FIELDEN INSTRUMENT DIVISION
2920 N. 4th St., Dept. A, Philadelphia 33, Pa.

Send full details on Fielden simplified:

☐ TEKTOLOG Electronic Recorder
☐ Resistance Thermometer Recorder
☐ TELSTOR Electronic Level Indicator
☐ MULTIPOINT Recorders
☐ TEKTOR Electronic Level Control
☐ Series 97 Temperature Controls

*Name*_____
*Title*_____
*Company*_____
*Address*_____ *City*_____ *State*_____

Fielden TEKTOLOG Recorder

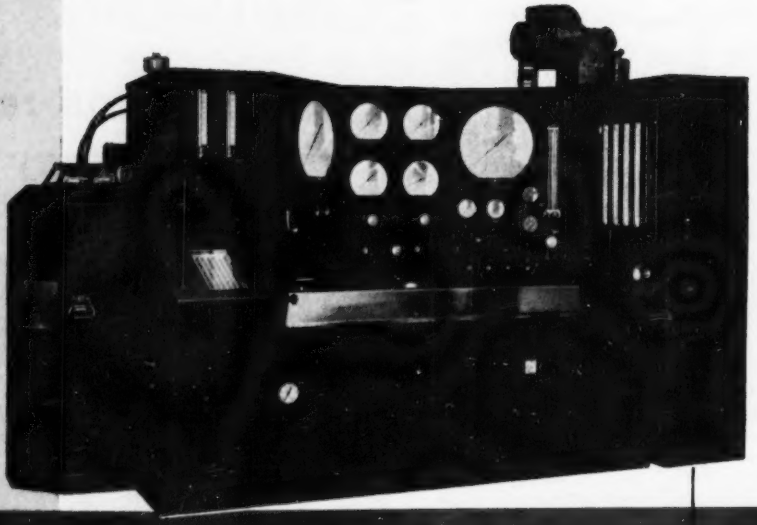
Fielden TELSTOR Indicator

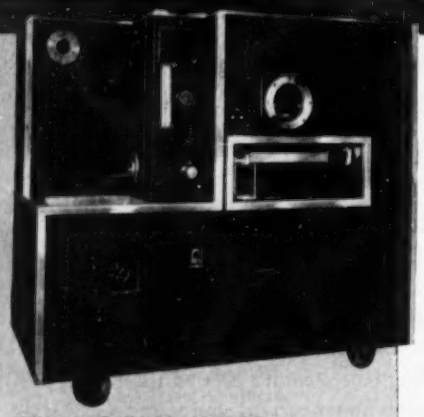
Fielden TEKTOR Control

For more information circle **52** on inquiry card.

COX TEST STANDS

STAND THE TEST OF TIME!





THE 309 FLOWMETER CALIBRATING STAND

More precision flowmeters are calibrated and checked on Cox Calibrating Stands of which the Type 309 is the latest, than on any other stand used by the automotive and aircraft industries. A precision-weighing mechanism weighs the flow through the flowmeter being tested, assuring precise calibration of the instrument. Portable Cox Calibrating Stands will accommodate single or multiple stage flowmeters of any make.

TYPE 416 UNIVERSAL FUEL NOZZLE TEST STAND

Used by the aircraft industry to test for optimum efficiency of jet fuel nozzles, this highly accurate Cox Test Stand is a "complete modern hydraulics laboratory." Pressure, temperature, and flow rate can be controlled during testing to simulate the actual conditions under which jet fuel nozzles normally operate in the engine.

• When automotive and aircraft manufacturers first encountered the problem of determining in advance how certain engine accessories would perform under actual operating conditions, Commercial Research Laboratories engineers developed special test stands which would supply this information.

To test for optimum efficiency of jet fuel nozzles, for example, the nozzle is mounted in a Cox Nozzle Test Stand in which temperature and pressure are controlled and fuel is passed through the nozzle at the rate required. The fuel is automatically weighed by an electronic weighing device within the test stand and from this information the nozzle rate of flow is computed.

Cox precision-weighing Calibrating Stands are equally indispensable to automotive carburetor testing since the flowmeters which are used to measure the exact flow rate must themselves be calibrated and regularly checked on these portable, highly accurate stands.

Despite the difficult tasks these and other Cox test stands are called upon to perform in helping industry to solve complex testing problems, they have built up an outstanding record of many years of dependable service and performance.

Write us for descriptive literature and complete details on these and other Cox Test Stands — including Air Flowmeters and Carburetor Flow Stands.

Other CRL *Products*

- **Single and Multiple Stage Flowmeters**
- **Engine Indicators**
- **Magnetic Thickness Gages**
- **Balanced Electronic Equipment for Measuring Pressure and Vibrations**
- **Vibration Study and Recording Equipment**

Commercial Research Laboratories, Inc.

20 BARTLETT AVENUE • DETROIT 3, MICHIGAN

Makers of REGISTERED TRADE MARK ***Since 1912***

For more information circle **53** on inquiry card.

NEW INSTRUMENTS

rectional instruments. Units wheel has fifty graduations: 125,000 increments per minute at maximum speed of 2500 rpm.—*Durant Mfg. Co.*, 1914 *N. Buffum St., Milwaukee* 1, *Wis.*

For more information circle **240** on inquiry card.

Counting Tube

New "Dekatron Model GC-10D" cold-cathode counting tube with a maximum input frequency of 20,000

counts per second is for use in fast registers and counters; may be used in conjunction with slower counting stages employing "Dekatron Model GC-10B" (4 kc. maximum). Resetting of tubes may be accomplished by a push button.—*Atomic Instrument Co., Cambridge, Mass.*

For more information circle **241** on inquiry card.

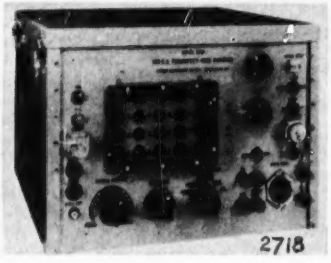
Production Counter

New "Model F-1 Decitron," designed to count continually at a speed of 2 to 3 per second, will count up to 7 objects per second during sudden bursts. Line voltages from 100 to 120 will operate system. Counter can be located as far away as 100 ft. from photohead. Photohead can be used in confined areas and counter mounted in plain view.—*Electronic Products Div., Post Machinery Co., Beverly, Mass.*

For more information circle **242** on inquiry card.

Militarized Time Counter

New "Model 3149" makes direct frequency and time measurements under field conditions with laboratory accuracy; features gold-plated switch contacts and JAN components throughout. Drip-proof cover can be removed in seconds. Direct measurement of frequency up to 150 kc. is provided by

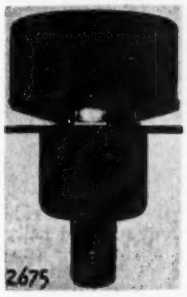


means of five electronic counter decades and crystal-controlled timer. Time intervals can be measured to nearest 0.00001 sec. Instrument also serves as a secondary frequency standard and as a totalizing counter.—*Potter Instrument Co., Inc., 115 Cutter Rd., Great Neck, N. Y.*

For more information circle **243** on inquiry card.

COMPUTING

Digital-recording Systems

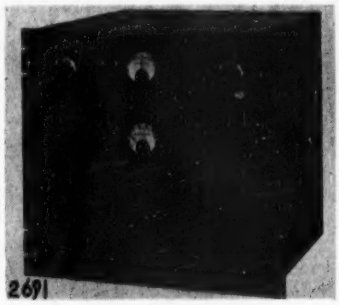


New digital magnetic recording systems feature magnetic-oxide-drums rotating on bearings operated at a small fraction of rated load. Present models have a medium storage capacity of 60,000 impulses or binary digits. Recording heads record and reproduce frequencies up to 1 Mc. Their all-ferrite magnetic circuits have multiple shielding, allowing information to be read on any channel while other information is being written on any other channel.—*Kollsman Instrument Corp., 80-08 45th Ave., Elmhurst, N. Y.*

For more information circle **244** on inquiry card.

Function Generator

New "Type G-1A Arbitrary Function Generator" is a special form of amplifier whose output signal can be related to input by any predetermined arbitrary function $y = f(x)$; de-



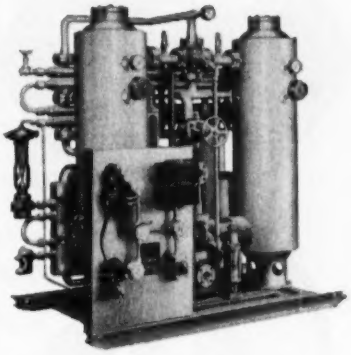
signed as a high-precision analog computer component; also well suited for handling non-linearities encountered in FM-FM systems. Signal components from zero frequency to several kc. can be handled. A standard laternslide template of function is inserted in instrument; photoelectric follower automatically keeps CRT beam exactly at template outline. Voltage required to position beam in y direction is amplified and used as output signal. —*William Miller Instruments, Inc., 325 N. Halstead Ave., Pasadena 8, Calif.*

For more information circle **245** on inquiry card.

Computer Triode

New "Type GL-6463" miniature twin triode is said to have higher perveance and plate current which will allow design of electronic com-

Pritchard
HYDRYER



IT ELIMINATES
MOISTURE PROBLEMS

This dependable Pritchard dehydration unit—a packaged dryer proved efficient in all types of industrial, processing and laboratory installations—reduces moisture content of air or other gases to desired dew points. That eliminates a lot of your moisture problems... gives you a good reason for owning a HYDRYER*. There are other good reasons, all of which will save you money.

Here are examples: A HYDRYER will eliminate costly plant and equipment shutdowns due to moisture and ice; it will protect precision instruments and controls; it will reduce corrosion, line losses, flow stoppages.

*Registered Trade Name

To find out all about HYDRYERs... and the many ways they can benefit you... write for your copy of Prichard's new HYDRYER bulletin, No. 16.0.081.

Industry's Partner for Progress

J.F. Pritchard Co.
OF CALIFORNIA
A DIVISION OF J.F. PRITCHARD & CO.
Dept. 342, 210 West 10th Street
Kansas City 5, Mo.

Representatives in Principal Cities From Coast to Coast

COOLING TOWERS • SPECIALIZED HEAT EXCHANGERS • GAS & AIR TREATING EQUIPMENT

For more information circle **54** on inquiry card.

Let us quote on your detailed requirements.

American Electronic Mfg., Inc.

9503 W. JEFFERSON BLVD., CULVER CITY, CALIF.
TELEPHONE: TExas 8-5471

For more information circle **55** on inquiry card.

NEW INSTRUMENTS

puters faster than many in current use. Plate dissipation of 4 watts per plate and 7 watts total for tube assures long dependable operation. Tube incorporates a special heater-cathode construction for dependability under frequent "on-off" switching. Average characteristics in amplifier service with 250 v. on plate and 620-ohm cathode bias resistor: amplification factor, 20; plate resistance, approx. 3850 ohms; transconductance, 5200 micromhos; plate current, 14.5 ma.—*Tube Dep't, General Electric Co., Schenectady 5, N. Y.*

For more information circle **246** on inquiry card.

SMOKE DETECTION, etc.

Air Pollution Indicator and Alarm

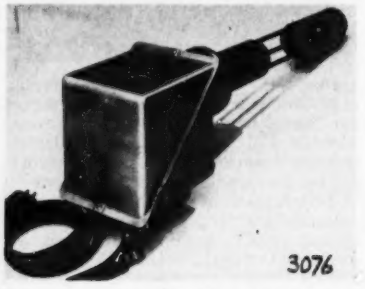
New "Model IA" is said to provide indication and alarm of smoke density at lowest possible initial cost; consists of light source, photoelectric re-

ceiver unit, and indicator unit with scale graduated in Ringleman numbers. Red and green lights show smoke above desired density or clear stack; red light can be set at any value desired. Indicating instrument and signal lights housing can be remotely located from light source and photoelectric receiver unit. These are located on opposite sides of breeching; mounted easily on ¾-in. pipe. Connections provided in indicator unit for bell, horn, etc.—*Eastern Controls Co., 10 E. 44th St., New York 17, N. Y.*

For more information circle **247** on inquiry card.

Smoke or Dust Detector

New "Model PDT Photo Detector" sounds alarm when smoke density in breeching exceeds local smoke ordinance; features quick low-cost instal-

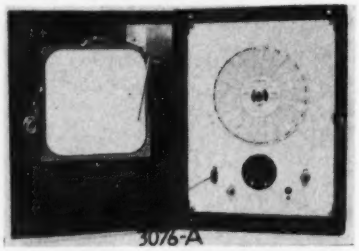


lation; is factory-set and cannot get out of alignment. Any failure other than current will continuously ring bell. Instrument can be used as a safety device for detecting dust or smoke elsewhere than in power plant. It may be remotely controlled by, and a continuous record may be obtained with, maker's "Model ROZ" inkless recorder.—*Larson Instrument Co., 24 Orchard St., Tarrytown, N. Y.*

For more information circle **248** on inquiry card.

Excess-variation Recorder

New "Model ROZ Inkless Operation Time Recorder" with "Zeroing Station" will remotely control "Model PDT Photo Detector Analyzer," will



record clock-time and duration of any variation beyond value preset by sensitivity adjustment; is used where "violation recording" is required. Inkless record on specially-treated circular chart is permanent and free from human error. Simplicity of chart pattern permits a non-technical operator to analyze record. No drying, developing or other processing. Various chart speeds.—*Larson Instrument Co., 24 Orchard St., Tarrytown, N. Y.*

For more information circle **249** on inquiry card

LIQUID LEVEL

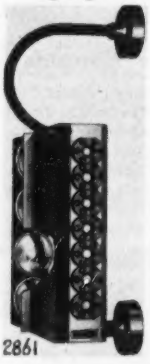
Float Switch

New float switch was originally designed for jet-plane fuel systems; operates at temperatures from –65 F.

to 200 F.; has passed rigid tests for endurance and for resistance to corrosion, salt spray, vibration, sand and dust, fungus, humidity, explosion, etc. —*Aero Supply Mfg. Co., Inc., Corry, Penna.*

For more information circle **250** on inquiry card.

High-pressure Level Gage



New "Multi-Port" gage for water-level indication in high-pressure boilers (up to 3000 psi.) features low maintenance because of simple construction and rapid easy replacement of inexpensive small mica, glass and gasket elements (done without removing gage from boiler); pressure and thermal stability because of design principle using small round ports; excellent readability of brilliantly-colored ports: green is water, red is steam, water level is always where colors meet.—*Diamond Power Specialty Corp., Lancaster, Ohio.*

For more information circle **251** on inquiry card.

FOR LABORATORY

Photofluorometer

New "Model 12C," though based on design of "Model 12," has sensitivity and stability greatly increased; de-

livers accurate data both at faint fluorescence levels and lower concentrations than those previously convenient to handle.—*Coleman Instruments Co., 318 Madison St., Maywood, Illinois.*

For more information circle **252** on inquiry card.

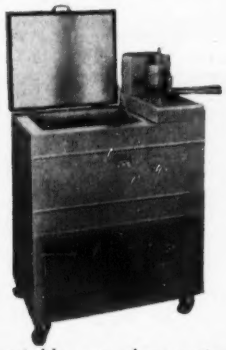
Immersion Heater

New "Chill Chaser" entirely automatic immersion heater yields economy of operation by heating liquids within baths, etc., where liquids absorb all generated heat. Adjustable thermostat maintains desired temperature within 1 F. Safety cut-out prevents element from overheating when out of solution. Adequate insulation prevents electric shock. Available immersion lengths, 5, 8, 10, 15, and 20 in. (specials to 48 in.); acid-resisting stainless steel. Units are rated at 1000 watts, plug into any 110 v.ac. outlet.—*The Still-Man Co., 433 E. 164th St., New York 56, N. Y.*

For more information circle **253** on inquiry card.

Low-temperature Bath and Circulating System

New "Lo-Temptrol" features a combination stirrer and pump, can be used as a low temperature bath



or a portable pumping system, etc. Two sizes with two temperature ranges: 15-gal. has range from room

If your industry or operation is here

BAKERY	PAPER MANUFACTURING
BEVERAGE	PETROLEUM REFINING, PRODUCING
BUILDING	PUBLIC UTILITIES
CANNERY	RUBBER PROCESSING AND PRODUCTS
CHEMICAL	SOAP MANUFACTURING
CONFECTIONERY	SUGAR REFINING
FOOD PROCESSING	RAILROADS
LAUNDRY	TANNERIES
MARINE	TEXTILE PRODUCTION, PROCESSING

There's a Sylphon Control to give you dependable, cost-saving regulation of temperature or pressure . . . . help improve your operations

● Fulton Sylphon supplies a complete line of controls for temperature or pressure, for a wide variety of uses. Let us helpyou select a Sylphon Control that will help *you* do a more efficient job, make cost-savings too. For helpful information, please write for Catalog PE-D.

Robertshaw-Fulton
CONTROLS COMPANY

FULTON SYLPHON DIVISION • KNOXVILLE 1, TENN.

For more information circle **56** on inquiry card.

to –30 C.; 45-gal., room to 0 C. "Micro-Set" thermoregulator controls temperatures to 0.01 C. at lower temperatures. "Lo-Temptrol" will circulate coolant at rate 3 gpm.—*Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.*

For more information circle **254** on inquiry card.

Wide-field Microscope

New "Model A" wide-field all-purpose microscope is not limited to inspection of specimen slides: can be used for study of crystals, documents, textiles, foods, parts and assemblies, etc. It is adjustable to 15, 45 and 75X. In addition to normal position, arm or tube may be inclined or reversed; tube may be removed and used as a pocket microscope. — *Testa Mfg. Co., 418 So. Pecan St., Los Angeles 33, Calif.*

For more information circle **255** on inquiry card.

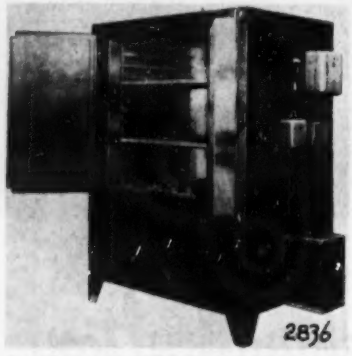
Oil Diffusion Pump

New "Mode 10" high-vacuum oil diffusion pump will increase evacuation speed 20 times when attached to a mechanical forepump; has an onset evacuating speed of 10 litres/sec. at 10^{-4} mm. Hg and a high ultimate vacuum of 5×10^{-6} mm. Hg; can easily be attached to any vacuum system used in a laboratory or pilot plant.—*Bronwill Scientific, Inc., 45 Russell St., Rochester 7, N. Y.*

For more information circle **256** on inquiry card.

Batch Type Ovens

New batch-type ovens, of heavy-duty convection type, are designed to fill needs of precision laboratory testing and small parts production. Either

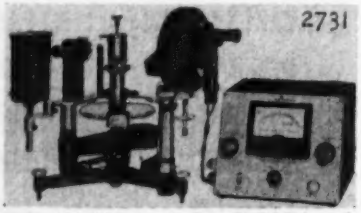


electric or gas-fired. Horizontal air flow (Models "HB" and "HA") with heating elements below work compartment; and vertical flow (Model "V") with heating elements in rear plenum chamber.—*Burdett Mfg. Co., 3433 W. Madison St., Chicago 24, Ill.*

For more information circle **257** on inquiry card.

Thin-film Ellipsometers

New "No. 430" (visual) and "No. 200-430" (photoelectric) "Ellipsometers" measure thicknesses of surface films with accuracy of ¼ Angstrom



unit (0.004 microinch). Principle: elliptical polarization of monochromatic light. Instruments embody numerous new refinements.—*O. C. Rudolph & Sons, P. O. Box 446, Caldwell, N. J.*

For more information circle **258** on inquiry card.

Paper Electrophoresis Power Supply

New "Model 20" power source, for use in conducting electrophoretic separations by paper strip method, is an inexpensive unit, measuring 5 x 10 x 3 in.; delivers 50 ma. (sufficient to process several strips simultaneously). A milliammeter indicates output current. Voltage is adjustable from 50 to 300 by a calibrated control.—*Biotron, P.O. Box 2014-D, Pasadena 2, Calif.*

For more information circle **259** on inquiry card.

NUCLEONICS

All-purpose Scaler

New "Model 192 Ultrascaler" for operation with Geiger, scintillation or proportional counters permits manual or automatic counting procedures including predetermined time or count operation or "time-count" operation to preset time or preset count (whichever occurs first); is also provided with a 60-cps. calibrating circuit; electrically reset timer; register; Eagle preset time clock; direct reading decade plug-in units; six-position scale selector switch coupled with a "precount" selector switch of 10, 100, or 1000 times scaling factor.—*Nuclear Instrument and Chemical Corp., 229 W. Erie St., Chicago 10, Ill.*

For more information circle **260** on inquiry card.

Spinthariscope

New "Geigerscope" is a 1-oz. pocket device used to detect and "measure" alpha rays. When "hot" specimen is held against small tapered end, viewer with eye at other end will see flashes, whose frequency indicates intensity of specimen's radioactivity. With each device comes a uranium ore sample for use as comparison standard.—*Ken Research, Inc., River Edge, N. J.*

For more information circle **261** on inquiry card.

Radioactivity Monitor

New "Model 1619 Labitron" is for use with a Geiger counter for (1) routine surveying for alpha, beta, or gamma contamination; (2) detecting large fluctuations in cosmic ray and other laboratory background; (3) routine radioactivity measurements. Four ranges cover up to 20,000 counts per minute. "Absolutely no zero drift." Built-in loud speaker. Chart type recorder may be connected.—*Nuclear Instrument and Chemical Corp., 229 W. Erie St., Chicago 10, Ill.*

For more information circle **262** on inquiry card.

Flow-type Counter

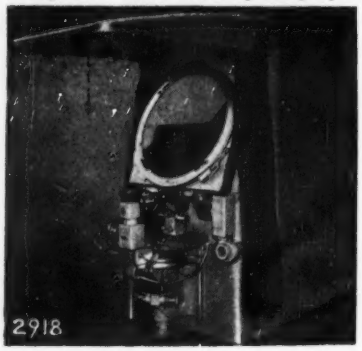
New "Model D47 Gas Flow Counter" is said to represent "an entirely new approach to the detection of atomic radiations." primarily to study complex biological processes using isotopes which emit low-energy short-range beta particles and whose efficient detection has previously been quite difficult, most radiations being stopped before they even reached inside of Geiger counter. In "D47," tissue or plant samples may be positioned as part of counter wall itself, or with only a "Micromil" window separation. Soft beta particles easily penetrate this 120 micrograms/cm^2 window. "D47" may be used with most commercial scalers or count rate meters.—*Nuclear Instrument and Chemical Corp., 229 W. Erie St., Chicago 10, Ill.*

For more information circle **263** on inquiry card.

DIMENSIONAL

Optical Comparator

New "Standard Model FC-30 Optical Comparator" features wholly integrated design, allows operator to stage cumbersome parts easily on low-level worktable and to work within inches of eye-level 30-in. viewing screen (56-⅜ in. from floor to centerline). Among many new features: Variable-speed power elevation provides quick precise measurements to 0.0001 in. with fingertip control. All measuring dials illuminated. For the first time, 5-in. and 8-in. capacity combined on one machine with easy changeover. Hood allows photographs



IN HOT DIMPLING HIGH STRESS METALS

WESTON *Sensitrol* RELAYS

CONTROL CRITICAL TEMPERATURES DIRECT FROM THERMOCOUPLE OUTPUT!

Ultra-Sensitive SENSITROL Relays . . .

- **Operate directly on values low as ½ microampere or ¼ millivolt.**
- **Handle substantial wattage at 110 volts on non-chattering magnetic contacts.**
- **Eliminate need for amplifiers and auxiliary power supplies.**
- **Available with single or double contacts, fixed or adjustable, manual or solenoid set.**

Hot dimpling of high stress materials for flush riveting used in today's airframes requires unfailing control of sheet temperatures within very close limits. Over temperatures might cause annealing and loss of strength, and under temperatures, inter-granular disorder and cracking.

To assure this precise and dependable control, Aircraft Tools, Inc. employ Sensitrol Relays in the Hot Dimpling Press illustrated, as well as in their portable dimpling tools. Operating directly from thermocouple output, these relays render the equipment inoperative should temperatures drop below a specified limit during dimpling; and also are used in the thermocouple break-circuit to prevent heater burn-out in case of thermocouple failure.

This is another instance where Sensitrol Relays have been adopted because they provide a positive means of control direct from feeble input signals . . . *without any amplification.* Some of their outstanding features are listed at the left. The complete story, in bulletin form, is available on request. WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, New Jersey. 8098

WESTON *Instruments*

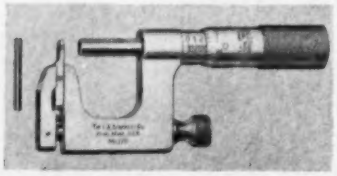
For more information circle **57** on inquiry card.

direct from viewing screen under adverse lighting conditions. Among other features: angle measuring with one-minute vernier; magnifications easily changed for shrink tolerances by means of a new positive mirror locator; 5 to 100 magnifications (up to 250 special); four table styles with lateral measuring ranges from 4 to 8 in. and capacity between centers from 8 to 24 in.—*Jones & Lamson Co., Clifton & Whitmore Sts., Springfield, Vt.*

For more information circle **264** on inquiry card.

Tube-wall Micrometer

New "Mul-T-Anvil" micrometer features interchangeable anvils; permits quick measurements from holes

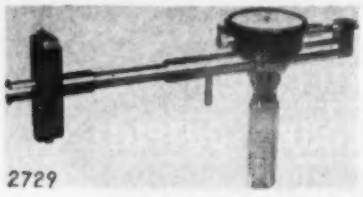


or slots to an edge and in hard-to-reach locations. Standard or special anvils are changed quickly, locked rigidly.—*The L. S. Starrett Co., Athol, Mass.*

For more information circle **265** on inquiry card.

Internal-groove Gage Heads

New "Y Series" internal groove gage head measures diameters of "O" ring grooves, snap ring grooves and



short counterbores; interchanges with all maker's other standard gage heads on standard gage bodies.—*Rimat Tool Co., 21 West Dayton St., Pasadena 2, Calif.*

For more information circle **266** on inquiry card.

Gage With Backstop

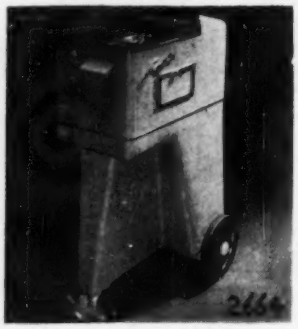
New "Geneva Dial Snap Gage" has large flat backstop which precisely positions workpieces, thereby speeding

operations. Pointed contacts can also be supplied for checking necks and grooves. Adjustable indicator dial has a positive internal lock for fine settings and may be fitted with tolerance hands or plate. Four models, with various capacities, ranges and graduations.—*Chicago Dial Indicator Co., 180 N. Wacker Drive, Chicago, Ill.*

For more information circle **267** on inquiry card.

Surface-profile Recorder

New "1063 Electrical Recorder" is designed to equip analytical measuring machines and hob and worm lead



machines for permanent chart records. Each graph reveals causes of errors; helps to improve a product because it indicates correction which must be made. Unique three-point pivotal base with cutout allows operator to stand close. Rubber wheels reduce vibrations transmitted through the floor.—*Illinois Tool Works, 2501 N. Keeler Ave., Chicago 39, Ill.*

For more information circle **268** on inquiry card.

Chamfer Micrometer Gage

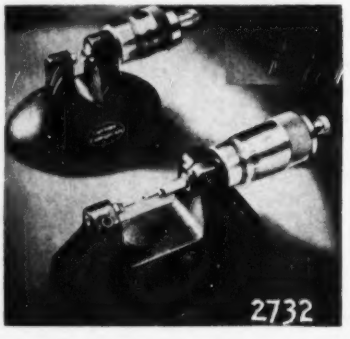
New "Model 127" directly reads end diameters of chamfers up to 1 in. from 90 deg. to 127 deg. included angle.

A master check bar, with known indicated end diameter and chamfer, is furnished for checking calibrations of micrometer.—*Acme Industrial Co., 200 N. Laflin St., Chicago 7, Ill.*

For more information circle **269** on inquiry card.

Bench Micrometers

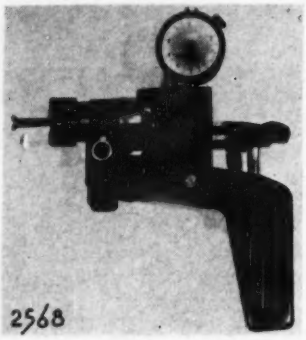
New bench micrometers read in 0.0001 in. directly on the 1-in. diam. thimble. Two models: "Type 40G," throat depth 1.600 in., tungsten carbide tipped measuring surfaces, range 0 to 4 in. "Type 40H," plunger-type spindle for eleven interchangeable sets of anvils; range 0 to 1 in., throat depth 1.280 in.—*George Scherr Co., Inc., 200 Lafayette St., New York 12, N. Y.*



For more information circle **270** on inquiry card.

Groove Gage

New "Undercut Measurement Gauge" measures "O" ring grooves, deep holes, tapers, recesses, inside spherical radii and out-of-round areas



to 0.0005 in. (closer readings depend upon operator). Hard-steel measuring tips are contracted by thumb lever while inserting in hole or recess. On release of lever, tips expand and indicate dimension. Continuously-variable i.d. measurement range 0.250 in. to 2.000 in. with standard tips. Special tips for extreme depth penetration and larger measurements; also for snap ring grooves.—*Mueller Laboratory, 239 W. Maple Ave., Monrovia, Calif.*

For more information circle **271** on inquiry card.

SHOP EQUIPMENT

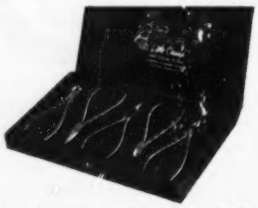
Micro Drills

New "Sphinx" high-speed steel drills are available in sizes 0.01 mm. apart starting with 0.08 mm. (0.003 in.), with oversize ground shanks and with either straight or spiral flutes.—*Louis Levin & Son, Inc., 3610 S. Broadway, Los Angeles 7, Calif.*

For more information circle **272** on inquiry card.

Pliers

New "Little Champ" line of precision pliers for fine bench work consists of five matched pliers designed



for electronics, watch and jewelry repair, etc. Available individually or as set of five in velvet-lined case.—*Champion DeArment Tool Co., Meadville, Penna.*

For more information circle **273** on inquiry card.

Torque-limiting Wrench

New "JOMI 4800," added to maker's line (heretofore up to 1600 lb.-in.), has 1200-4800 lb.-in. range ad-

No maintenance problems with this instrument!

In spite of all of the development work being done on automatic control instruments, the Bristol Series 500 Air-Operated Controller is still the most dependable and trouble-free — as proved by thousands of installations. And here's why:

It's the simplest to service. Only one adjustment with a ¼ in. wrench calibrates the control system. No other adjustment is needed. Control system can be completely disassembled and, after reassembly (even with replacement parts), can be *exactly calibrated by this one simple adjustment.*

It's completely reliable. One user states, "I'm amazed at the way this instrument performs day-in and day-out with little or no attention. We call it the work-horse controller in our plant. And our plant men like to use it, because it gives them the precision results they need without having to fuss with it".

Its settings are exactly reproducible. Reset rate, derivative time, and proportional band adjustments are accurately calibrated and exactly reproducible. You can instantly reproduce established settings without cut and try.

It uses the world-famous Bristol measuring elements. The measuring systems used in Bristol Series 500 Air-Operated Controllers for TEMPERATURE, PRESSURE, FLOW, VACUUM, DRAFT, ABSOLUTE PRESSURE, LIQUID LEVEL, pH, AND HUMIDITY are the result of 65 years of experience in instrument making and application in practically every industry. Bristol measuring elements are recognized the world over for their accuracy, simplicity, and reliability. There just aren't any better measuring elements made than Bristol's.

For more facts and figures about the Series 500 Air-Operated Controllers, write for free 32-page bulletin A120. The Bristol Company, 113 Bristol Road, Waterbury, Connecticut.

4.27

TRADE MARK
BRISTOL'S
REG. U.S. PAT. OFFICE

BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **58** on inquiry card.

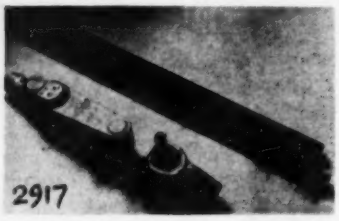
NEW INSTRUMENTS

justable in 10-lb.-in. increments. Accuracy: tool is guaranteed to release within 3 percent plus 2 lb.-in. within entire range.—*Jo-Line Tools, Inc.*, 8442 *Otis St., South Gate, Calif.*

For more information circle **274** on inquiry card.

Torque-limiting Wrench

New "JOMI 1202" expands maker's line by making available for thread sizes from No. 4 to 2 in. Its range is

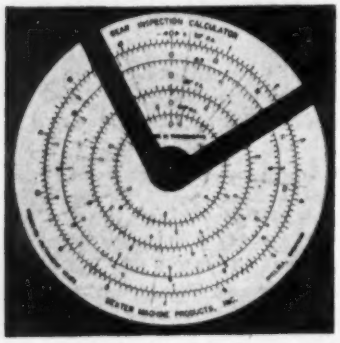


300 to 2000 lb.-ft., adjustable in 50-lb.-ft. increments. Accuracy: tool is guaranteed to release within 3 percent plus 10 lb.-ft. within entire range.—*Jo-Line Tools, Inc.*, 8442 *Otis St., South Gate, Calif.*

For more information circle **275** on inquiry card.

Gear Calculator

New "Gear Inspection Calculator" determines relationship between tooth thickness and radial displacement and



total composite error for pressure angles of 30, 20 and 14½ deg. when gear is inspected on a gear rolling fixture.—*Dexter Machine Products, Inc.*, 20451 *U. S. 12 West, Chelsea, Mich.*

For more information circle **276** on inquiry card.

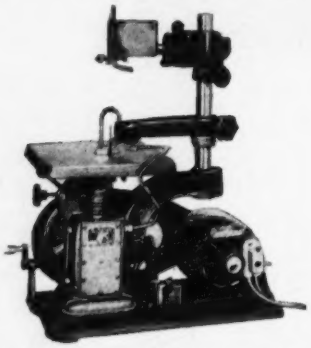
Bonding Material

New "Tygoweld" is an organic welding material whereby metal-to-glass, metal-to-porcelain, as well as metal-to-metal adhesion surpass rugged peel and shear tests; yet welding technique does not require open flame or arc. "Tygoweld" comes in rod form; can be applied with moderate heats and little or no pressure. Also available are powder and paste adaptations of new material; also special color and filleting characteristics.—*U. S. Stoneware Co., Research and Development Laboratories, Akron, Ohio.*

For more information circle **277** on inquiry card.

Filing Machine

New "Precision Filing Machine" is adaptable to wide range of filing, honing and sawing uses in labora-

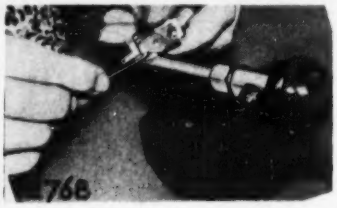


tories. Infinitely-variable speed: 170 to 470 strokes per minute. Four-face file-setting square has precision ground V-groove, and three faces finished to 0, ½ and 1 degree angles for table setting.—*All American Tool & Mfg. Co.*, 8027 *Lawndale, Skokie, Illinois.*

For more information circle **278** on inquiry card.

Fixed-base Soldering-iron

New "Model F Standiron" is a fixed-base electric soldering iron said to increase sub-assembly production



as much as 30 percent; mounts vertically or horizontally, freeing hands of operator.—*Vari Corp.*, 619 *Fourth Avenue South, Minneapolis* 15, *Minn.*

For more information circle **279** on inquiry card.

Double-flaring Tools

Two new tools for making double lap flares for flared fitting joints on brazed or welded steel tubing, such as Bundy or GM, and also on copper or aluminum tubing, are respectively for making 45-deg. and 37-deg. double flares. Two operations: tubing is belled (Fig. 1); tube is folded down

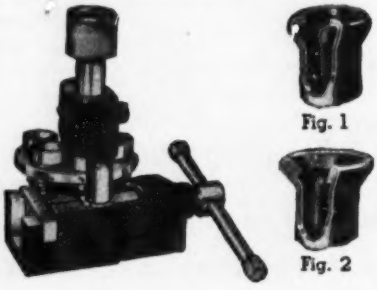


Fig. 1

Fig. 2

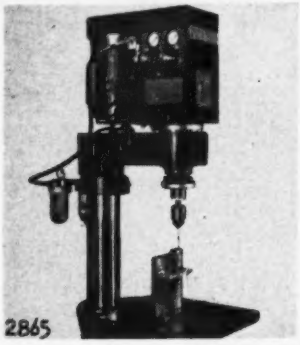
over itself (Fig. 2) making a double thickness flare. Tools will also make single flares.—*The Imperial Brass Mfg. Co.*, 1200 *W. Harrison St., Chicago* 7, *Illinois.*

For more information circle **280** on inquiry card.

MACHINE AUTOMATION

Automatic Drill Unit

New "Series 24" self-contained automatic drill unit operates on low air volume, is simple to set up. Op-



tional hydraulic control accessory (separate from air circuits) controls the rate of feed for drilling hard materials at special angles or on curved surfaces, etc. Optional repeat cycle timer for deep hole drilling, etc.—*The Dumore Co., Inc., Racine, Wis.*

For more information circle **281** on inquiry card.

Air-feed Drill Head

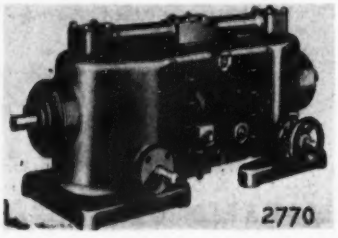
New "Model AH-5" high-speed drilling head has air feed with hydro check control; is 12½ in. over-all length and 2 in. wide, with full 2-in.

stroke and fast return; is said to be ideal for multiple-spindle drilling. Sides and bottom machined square and parallel to spindle to simplify alignment. Also available mounted on T base with automatic air control box and electrical cycle timer.—*Telematic Corp.*, 3338 *S. Robertson Blvd., Los Angeles* 34, *Calif.*

For more information circle **282** on inquiry card.

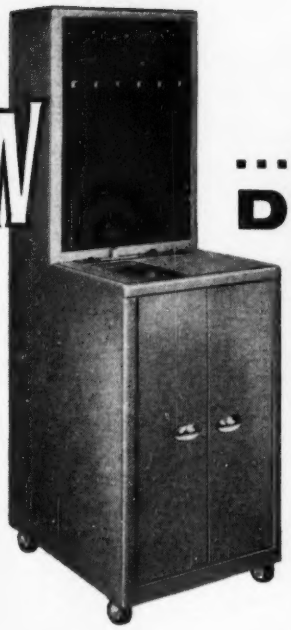
Variable-speed Hydraulic Transmissions

New variable-speed integral hydraulic transmission units have variable-displacement axial-type piston



The new Type M Dynograph Recorder is a high speed direct writing oscillograph providing exceptionally high, absolutely stable, d-c or a-c amplification. It may be used with reluctance type pick-ups without auxiliary equipment. The exceptional stability, sensitivity, and versatility of the Dynograph allow simultaneous direct recordings of a very wide variety of transient variables such as temperature, speed, position, pressure, acceleration, vibration and strain.

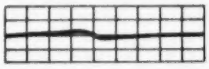
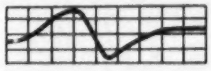
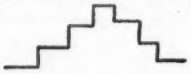
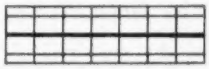
The Type M employs individual plug-in amplifiers; and input panels provide all connections for various types of signal pick-ups. It is the most advanced equipment for your direct-writing recording problems.



NEW ...OFFNER TYPE M DYNOGRAPH RECORDER

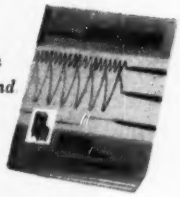
WHY THE DYNOGRAPH? For almost every application of direct writing oscillographs, those who have compared features of competitive instruments have chosen the Dynograph—because:

The Dynograph provides *thirty times* the d-c sensitivity of competitive instruments.*

Instead of a barely readable record like this: 	The Dynograph gives a large, easily read record like this: 
Yet while competitive recorders drift 1 mv per hour* or more—	The Dynograph is absolutely non-drifting.
Other recorders require additional amplifiers or preamplifiers for moderate gain d-c; for high gain d-c; for carrier applications (strain gauges or reluctance bridges).	With the Dynograph, one amplifier covers all applications—and does a better job on each!
Pen friction and low torque gives hysteresis on many recorders. 	There is no measurable hysteresis on the Dynograph.
Limited pen travel makes recording of large dynamic variations difficult.	Over 8 cm of pen excursion is available in the Dynograph.
Even at moderate sensitivities, other assemblies require considerable warmup time for stabilization.	The Dynograph is stable as soon as it is working.

* Based on manufacturer's published claims.

COMPARE AND YOU WILL SELECT THE DYNOGRAPH

Eight page, 2 color bulletin describes technical details and application information. Write for your copy of Bulletin L-742.



OFFNER ELECTRONICS INC.

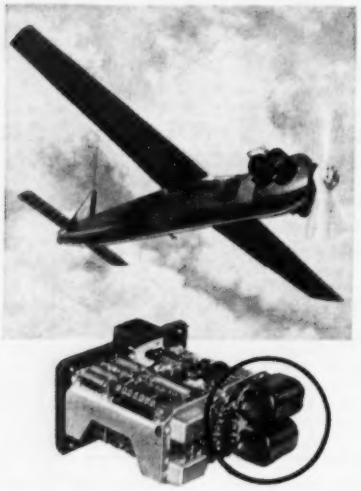
5326 N. Kedzie Ave., Chicago 25, U.S.A.

For more information circle 59 on inquiry card.

BARBER COLMAN

ultra-sensitive relays

On Radioplane Co. Radio Controlled Aerial Targets for gunnery practice



Type OQ-19 Radio Controlled Aerial Targets—sometimes called RCATs—are now the standard targets used in gunnery training of anti-aircraft and airborne gunnery crews of the Armed Forces. Product of Radioplane Co., a subsidiary of Northrop, these drones are maneuvered from the ground to simulate enemy attacks. Barber-Colman Micropositioners, ultra-sensitive polarized relays, constitute the output stage of the auto-pilot on the RCAT and position the control surface actuators through intermediate relays. Ideal for hundreds of aircraft and industrial applications, Barber-Colman d-c polarized relays have high-speed response and are available in a wide range of sensitivities, coils, enclosures, and mounting details.

Write today for Bulletin F3961-2

BARBER-COLMAN COMPANY
Dept. I. 1415 Rock Street, Rockford, Illinois

For more information circle **60** on inquiry card.

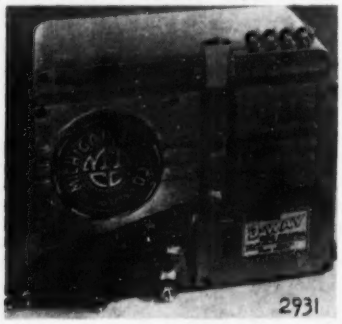
NEW INSTRUMENTS

pumps and hydraulic motors, and suitable valves and controls enclosed in a bolted cast-iron housing assembly. They can be run constantly at any selected speed to 1,000 rpm. Selected acceleration and deceleration rates are constant and stepless throughout absolute speed range of each transmission.—*Vickers Inc.*, 1400 *Oakman Blvd., Detroit* 32, *Mich.*

For more information circle **283** on inquiry card.

Automatic Gear Selector

New "Automatic 3-Way Gear Selector" segregates 100 percent of gears produced into satisfactory, oversize,



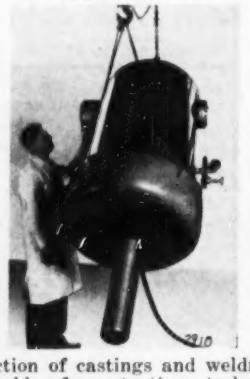
and undersize; can be coupled to inspect any spur or helical gear at a faster rate than it can be produced. Machine operator feeds gears into new selector, or gears can be inspected in a fully automatic setup without requiring operator attention. ★ Unit can be furnished with automatic shut-off, coupled with counter, to stop production machine if any (preset) number of consecutive gears is rejected, or if percentage of rejects on a given run exceeds set limits.—*Michigan Tool Co.*, 7171 *E. McNichols Rd., Detroit* 12, *Mich.*

For more information circle **284** on inquiry card.

MECHANICAL TESTING AND INSPECTION

Industrial X-ray Generator

New Van de Graaff ("atom-smasher") type but low-cost one-million-volt x-ray generator for industrial

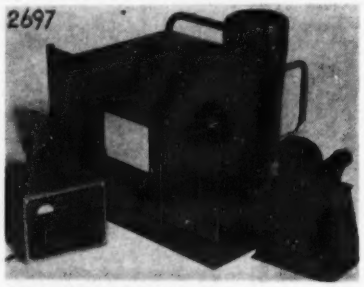


inspection of castings and weldments is capable of penetrating steel thicknesses up to 5 in. Feature is its ability to cast sharp x-ray shadows.—*High Voltage Engineering Corp.*, 7 *University Rd., Cambridge* 38, *Mass.*

For more information circle **285** on inquiry card.

Industrial X-ray Unit

New "MG 60" fluoroscopy and radiography unit is compact and portable (46 lbs.); is designed for continuous operation; has 1-mm.-focal-spot x-ray

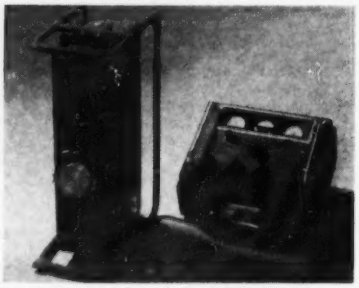


tube, thus providing excellent radiographic and fluoroscopic results.—*Research & Control Instruments Div., North American Philips Co., Inc.*, 750 *S. Fulton Ave., Mount Vernon, N. Y.*

For more information circle **286** on inquiry card.

Industrial X-ray Units

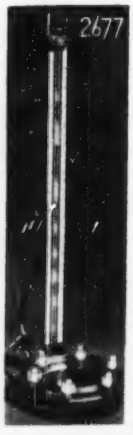
New "Baltograph" line of portable industrial x-ray equipment is said to feature maximum penetration for minimum weight. Self-contained x-ray



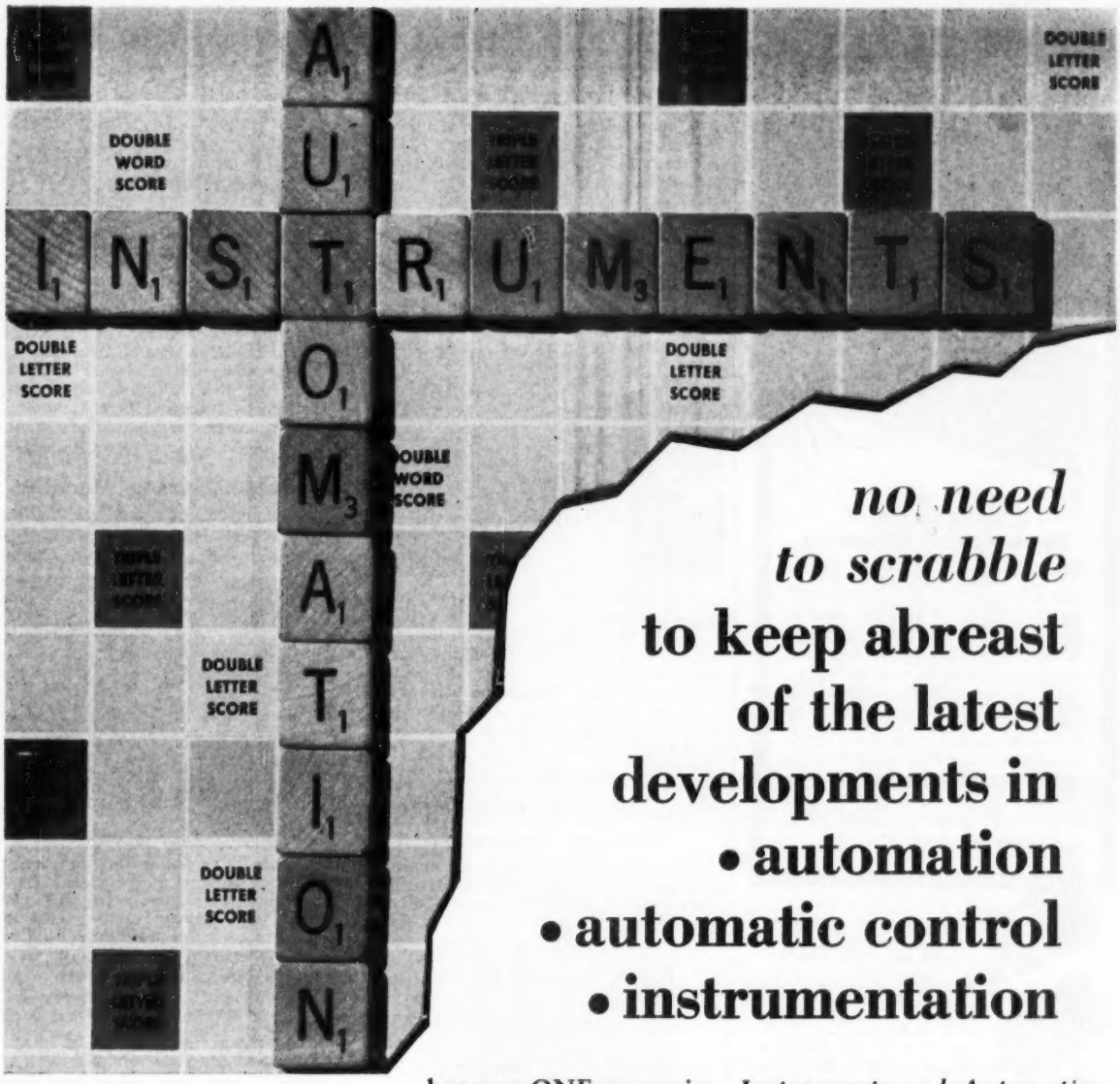
head of model rated at 195 kv. 5 ma., weighs 153 lbs. and measures 26½ x 14 x 8¼ in. Head houses both x-ray tube and high-voltage transformers said to be of radical new design. No cooling pumps or special accessories.—*Balteau Electric Corp., Stamford, Conn.*

For more information circle **287** on inquiry card.

Tester for Stresses in Platings, Lacquers, etc.



New "Stresometer" is for measuring stresses in chemically-deposited metals, electroplated metals, and paint, lacquer and plastic films, caused by shrinkage or expansion of deposited layers; from 100,000 psi. in tension (contractile) to 50,000 psi. in compression (expansive). Principle: a flat metal disk dishes in or bulges out according to whether material deposited on it shrinks or expands. Deflection, magnified more than a thousand times by a hydraulic arrangement, is read on linear stress scale of instrument. Instrument can be used directly in plating tank



no need to scrabble to keep abreast of the latest developments in

• automation
• automatic control
• instrumentation

because ONE magazine, *Instruments and Automation*, offers the MOST COMPLETE coverage of the field of instrumentation and control.

EACH month, I & A pictures and describes approximately 200 new instruments and automatic controls.

THIS coverage is vital, for in it lies your key to continued success in finding better ways to production through instrumentation.

FULL-length articles and special application shorts also play important roles in helping you keep in step with this constantly expanding field. Here, for example, are just a few of the special features soon to be presented to I & A subscribers:

- *November*, post-ISA-show issue, reports new and outstanding devices exhibited at the First International Instrument Exposition.
- *December*, brings to all our subscribers as Part 2 of that issue, the separately bound "Handbook of Measurement and Control"—a revised and up-to-date second edition.
- *January* will feature the complete report of the First International Automation Exposition.

In addition to helping you unscrabble the maze of new developments, applications, and products in your field, I & A can also save you $$ in gathering the information and data you want and need. Our regular subscription price is $4.00 per year (the Handbook alone is worth many times this); but through our group subscription plan, you can slice this price in half! Five separate one-year subscriptions, on one order, $10.00. Savings also on 4, 3, or 2 grouped subscriptions. (Use card on page 1509)

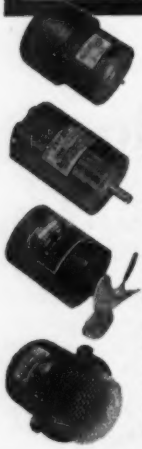
THE INSTRUMENTS PUBLISHING CO.
845 RIDGE AVE., PITTSBURGH 12, PENNA.

Headquarters for instrument information since 1928

15 Horse Power in a 7"x 11" case!

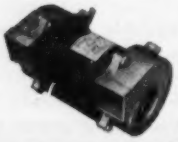
A typical example of American Electric engineering

This 400 cycle 3 phase motor is a special custom-developed aircraft design. Rated at 15 h.p. continuous duty at 11,500 r.p.m., it actually produces 19 h.p. on intermittent duty, yet occupies less than ¼ cubic foot. Weight is 32 lbs.–approximately ½ h.p. per lb. Fungus-proof, corrosion resistant, meets AND 20002 type XIIB mounting specifications. Temperature range: −67° to +131° F. Motor length: 7", Coupling extension 4".



MINIATURE MOTORS for all PURPOSES!

American Electric Motors are also built in an almost unlimited range of miniatures for 60 and 400 cycle operation as well as variable frequencies. All feature low weight, compact size and meet high temperature requirements. Supplied in induction or synchronous types for motor drives, propeller fans and centrifugal blowers. Wire, write or phone for data and quotations.



Also Manufacturers of High Cycle Motor-Alternators and A.C. Industrial Motors.

AMERICAN ELECTRIC MOTORS

DIVISION OF AMERICAN ELECTRONICS, INC.
FIELD ENGINEERING REPRESENTATIVES:
Silver Spring (Md.) • Boston • Buffalo • New York City • Chicago • Dallas • Kansas City • Wright Field • Minneapolis • Seattle • Montreal • Toronto
JOE DAVIDSON & ASSOCIATES, Los Angeles

For more information circle **61** on inquiry card.

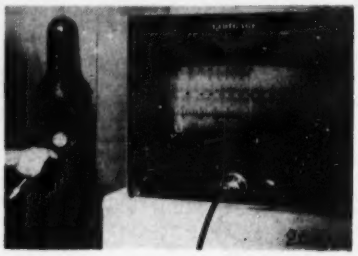
NEW INSTRUMENTS

for control purposes, or for research with separate tank. One model made of high-temperature Lucite (for plated and deposited metals); other of metal (for films).—*Joseph B. Kushner Electroplating School,* 115 *Broad St., Stroudsburg* 1, *Penna.*

For more information circle **288** on inquiry card.

Thickness Gage

New "Vidigage" ultrasonic gage for measuring thickness features a 21-in. TV tube. Thickness is indicated directly on screen which allows for



scales 17 in. long. "Vidigage" also detects laminar flaws, including lack of bond, non-destructively, from one side of work. Sweep-width adjustment permits an almost infinite choice of thickness scales. Minimum thickness 0.012 in. Circuits have been improved so that thickness indication on screen is a single sharp line.—*Branson Instruments, Inc.,* 430 *Fairfield Ave., Stamford, Conn.*

For more information circle **289** on inquiry card.

Tension Analyzer

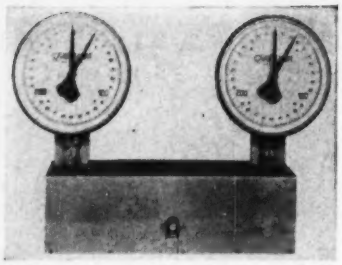
New "TM Tension Analyzer" measures and records instantaneous tension loads in filamentary materials; is equally applicable to all textiles and

to fine wire of reasonable flexibility. Material whose tension is to be measured is placed over three pulleys; displacements of center pulley are converted into electrical signals which are amplified and recorded on direct-writing oscillograph.—*Brush Electronics Co., Equipment Dep't RT-2,* 3405 *Perkins Ave., Cleveland* 14, *Ohio.*

For more information circle **290** on inquiry card.

Torque Tester

New "Model No. 574" is available in capacities from 50 oz.-in. through 1000 lb.-in. and in graduations from 0.25 oz.-in. through 4 lb.-in.; is extremely simple to operate; may be used for clockwise or counter-clockwise measurements from same side.

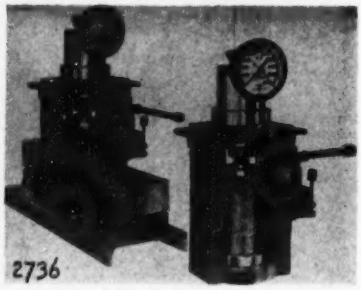


Guaranteed accurate to one graduation. Maximum-reading pointers, magnetic tolerance pointers, and additional dynamometer heads available as optional equipment; also a checking factor for dead-weight test for all capacities.—*John Chatillon & Sons,* 85 *Cliff St., New York* 38, *N. Y.*

For more information circle **291** on inquiry card.

Portable Testing Machine

New 200,000-lb. portable testing machine makes possible rapid on-the-job testing of concrete and similar

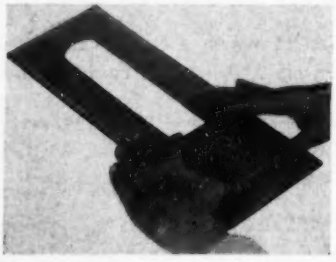


materials with laboratory accuracy; is simple to operate; meets ASTM and AASHO specs; can be rapidly converted to a flexure testing machine for beam tests; or used as a high capacity shop or laboratory press.—*Soiltest, Inc.,* 4520 *West North Ave., Chicago* 39, *Ill.*

For more information circle **292** on inquiry card.

Film Applicator

New "Ultra Applicator" lays down wet test films of plastic coatings,

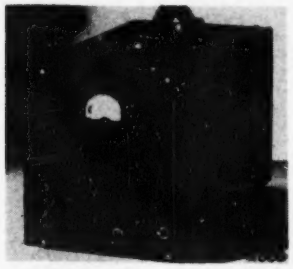


paints, adhesives, etc. to comply exactly with requirements of various test methods.—*Gardner Laboratory, Inc., Bethesda* 14, *Md.*

For more information circle **293** on inquiry card.

Strain-gage Terminal

New "Model 125," for use with maker's "Model 220 Wide-Band D-C Amplifier" or other instruments with differential input, contains: metered voltage source to energize resistance strain-gages; provisions to obtain initial bridg balance; precision re-



sistors which may be used to complete bridge circuit if fewer than four external strain-gages are used; selector switch to permit connecting these resistors in any one of three common circuits.—*Furst Electronics, 3322 W. Lawrence Ave., Chicago 25, Ill.*

For more information circle **294** on inquiry card.

Automatic Cable Inspector

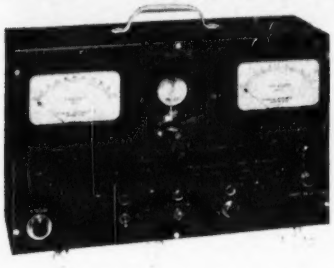
New "Cable Inspector" is an automatic electric-wiring inspection system based on continuous scanning cir-

cuitry developed by maker for chemical processing industry. Among features: automatic megging. Standard model checks insulation resistances to 110 megohms at 350 v. dc. (higher resistances and voltages can be furnished). The 10,000 tests required for insulation resistance check of a 100-conductor cable can be performed in 200 seconds by one operator.—*Panascan, 7407 N. Hamlin Ave., Skokie, Illinois.*

For more information circle **295** on inquiry card.

Vibration Analyzer

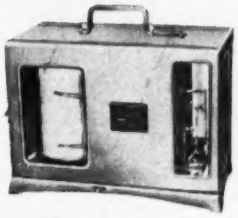
New combination instrument measures amplitude and frequency of out-of-balance conditions in rotating or moving mechanisms; has six amplitude ranges, two frequency ranges, a relative phase-angle indicator for synchronous analysis, two pick-up connections, a variable frequency oscillator for tachometer application, a strobotron flash, front panel terminals for connecting oscilloscope, and fused protection. Optional accessories include carrying case, strobotron, two pick-ups, either hand-held probe or mountable flat base types, frequency



TESTED

AIR INSTRUMENTATION BY BENDIX-FRIEZ

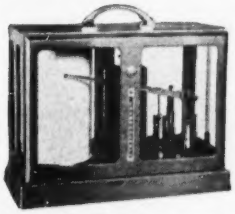
FOR RECORDING TEMPERATURE, HUMIDITY



HYGRO-THERMOGRAPH The leader in its field. Noted for precise accuracy and long-time dependability. Portable, easy to operate. Widely used in laboratories, factories and offices.

PORTABLE TEMPERATURE, HUMIDITY RECORDER Rugged, compact design. Ideally suited for use in small space and difficult locations. Provides convenient 3 x 5 charts for 10 or 30 hour records.

FOR CHECKING BAROMETRIC PRESSURE



MICROBAROGRAPH A key meteorological instrument. Records atmospheric pressure to within 0.01 inch mercury. Record chart expanded 2½ times for greater visibility.

ANEROID BAROMETER Inexpensive, dependable, easy-to-read. Shows pressure and barometric tendency. Housed in handsome brass case. Favored by professionals and amateurs alike.

FOR MEASURING WIND SPEED, DIRECTION

SINGLE CHART AEROVANE RECORDER New flush mounted recorder for wind speed and direction. Each gust or lull, from breeze to hurricane, accurately ink plotted and recorded on a single continuous strip chart.

AEROVANE Indicates and records wind speed and direction. Recognized as "best all-purpose wind measuring instrument yet devised." Readily installed and easily maintained.

FRIEZ INSTRUMENT DIVISION OF
1408 Taylor Avenue • Baltimore 4, Md.

Bendix

Export Sales
Bendix International Div., 205 E. 42nd St., New York 17, N.Y.

AVIATION CORPORATION

For more information circle **62** on inquiry card.

Viking
miniature
connectors

DESIGNED FOR
LONG, RELIABLE
SERVICE LIFE

VIKING circular types. Positive polarization and shielding. Simple locking device mates units against vibration. One to four contacts on small units—5 to 9 on large units.

VIKING printed circuit receptacle. Increases your circuits—unit shown has 20 contacts, and is interchangeable with 18-contact types. Extremely strong contacts, pierced or unpierced.

Hermetic sealing is available on the circular and rectangular series. Write for literature on these or the complete line of VIKING connectors.

VIKING
ELECTRIC
1061 INGRAHAM STREET
LOS ANGELES 27, CALIF.

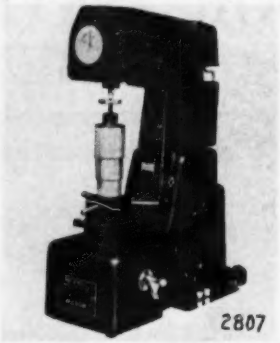
For more information circle **63** on inquiry card.

meter calibrated in either cps. or rpm., and any reasonable length cables. Total weight 38 lbs.—*Technical Instrument Co., 3732 Westheimer Rd., Houston, Texas.*

For more information circle **296** on inquiry card.

Motorized Hardness Tester

New "Model Y Rockwell Motorized Hardness Tester" is semi-automatic in operation. Motor's function in test

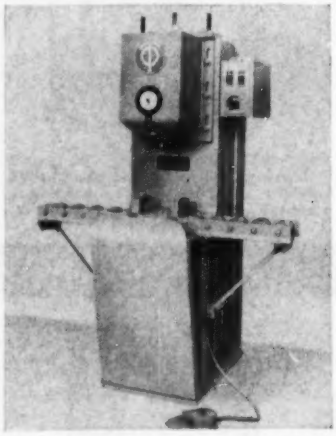


cycle is to remove major load. Cycle of major load operation is less than 2 seconds. Dash pot gives infinitely-variable speed control.—*Wilson Mechanical Instrument Div., American Chain & Cable Co., Inc., Bridgeport, Conn.*

For more information circle **297** on inquiry card.

Automatic Hardness Tester

New "Conveyorized Automatic Brinell Hardness Tester" enables hardness tests to be made at rate of

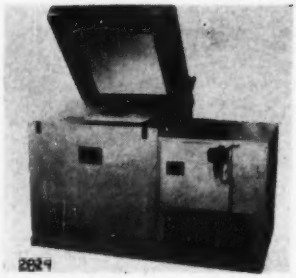


10 or more specimens per minute; has built-in roller conveyor and air-operated lift; all operations controlled by pedal.—*Tinius Olsen Testing Machine Co., 1116 Easton Rd., Willow Grove, Pa.*

For more information circle **298** on inquiry card.

Low-temperature Cabinets

New cold treatment units, for testing, storage and processing, feature rapid temperature pull-down; range –60 F. to –170 F.; semi-hermetic compressors; fan-and-coil arrangement



for air circulation within cold chamber. Available with caster assembly for mobile operation. Prompt delivery. —*Bowser Technical Refrigeration, Terryville, Conn.*

For more information circle **299** on inquiry card.

Explosion Test Chamber

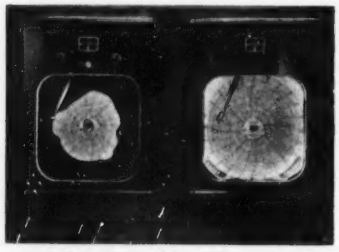
New explosion test chamber permits high-octane aviation gas to be exploded at any simulated altitude to

50,000 ft.; meets USAF spec MIL-E-5272A and provides extra safety through two pressure relief valves, each more than ample.—*American Research Corp., 11 Brook St., Bristol, Conn.*

For more information circle **300** on inquiry card.

Environmental-test Controllers

New complete line of control instruments for use with artificial environment test cabinets can be used to initiate and maintain an entire



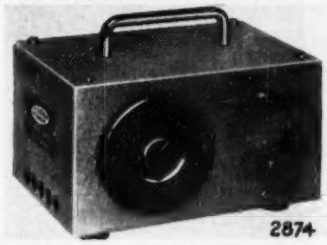
program of varying climatic conditions and to simulate any desired temperature, humidity, or altitude conditions. Available in one- or two-case models depending on application, with electric on-off or proportional input control, or with pneumatic control in proportional, reset, or derivative modes.—*The Bristol Company, Waterbury 20, Conn.*

For more information circle **301** on inquiry card.

ELECTRICAL TESTING

Ground-conductor Tester

New "Type 121 Terra-Tertia Test Unit" is a safety-factor device for rapidly testing ground conductor efficiency of portable electric tools. It is

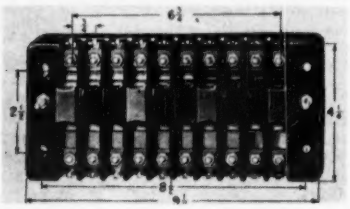


connected to 220-250 v.ac. and tool plugged into 15-amp. three-pin socket on front panel, with body of tool pressed against instrument's handle; panel-switch is then depressed. If conductor is satisfactory, lamp lights.—*Electro Methods Limited, Caxton Way, Stevenage, Herts., England.*

For more information circle **302** on inquiry card.

Test Switch

New "Tesco Test Switch" is said to be "the first real improvement in test switches in many years." Principle: fixed contacts and a sliding



link; low contact resistance assured by heavy spring. All clearances ample, minimum of ⅝ in. surface leakage distance between live parts, or live parts to ground. Single moving part slides up and down in space between barriers, so that construction is nearly dead-front.—*Eastern Specialty Co., Philadelphia 40, Pa.*

For more information circle **303** on inquiry card.

Multi-range Test Set

New "Model 120" is 20,000 ohms per v.dc., 5,000 ohms per v.ac., said to "out-range any professional V-O-M of similar size or type." It has 44 self-contained ranges: an extra-low resistance range affords a 2-ohm center scale; an extra-low voltage range offers 1.2 v.ac. & dc. full scale; an extended low dc. current range starts at 0-60 microamperes. Range selection through an 18-position positive-detenting master range selector with low-resistance silver-plated contacts; easy-reading scale-face with 4¾-in. wide window.—*Precision Apparatus Co., 92-27 Horace Harding Blvd., Elmhurst, L. I., N. Y.*

For more information circle **304** on inquiry card.

Tube Tester

New "Model 372P" portable (9½ lbs.) tube tester is said to "promise to revolutionize the tube testing market." It will test all latest radio and TV receiver tubes, picture tubes (including color). Unique design of tab index tube chart gives quicker refer-

When you measure TIME look to HAYDON*

TIME DELAY RELAYS

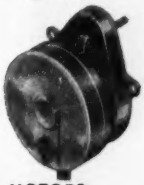
5900 Series: For time delay or interval timing in ranges from 0 to 10 minutes.

INTERVAL TIMERS

8006 Series: Times intervals from 60 seconds to two weeks with exactness.

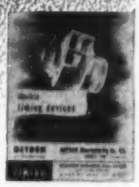
ELAPSED TIME INDICATORS

5700 Series: Registers passage of time in minutes and tenths of minutes and hours with mathematical regularity.



TIMING MOTORS

Compact HAYDON Timing Motors that can be operated continuously in any position drive all HAYDON Timing Devices. HAYDON specializes in timing; engineers and builds only timing components; has the "know how" to put time to work for you.



TAKE TIME NOW to write for the name of your HAYDON Timing Specialist, and for HAYDON Catalog.

HAYDON AT TORRINGTON

A SUBSIDIARY OF GENERAL TIME CORP.

HEADQUARTERS FOR TIMING

HAYDON Manufacturing Company, Inc.
2033 ELM STREET, TORRINGTON, CONN.

☐ Send me "Electric Timing Devices" catalog.
☐ Send me name of HAYDON Timing Specialist.

NAME _____
TITLE _____
COMPANY _____
CO. ADDRESS _____
CITY _____ ZONE ___ STATE _____

*Trademark Reg. U.S. Patent Office

For more information circle **64** on inquiry card.

LITTLEFORD

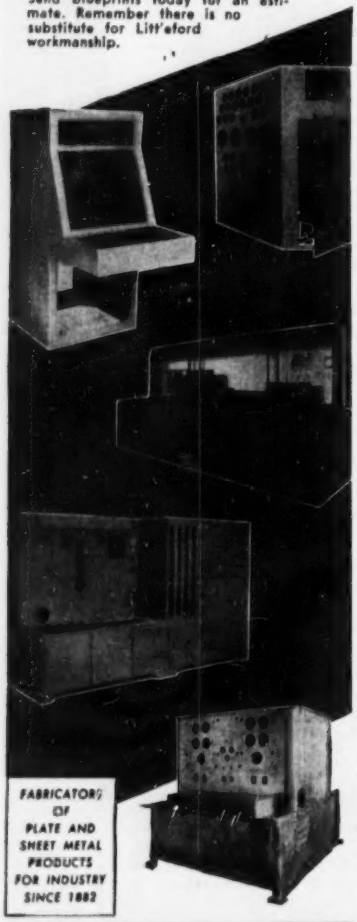
CABINETS • • •

and

PANEL BOARDS

Accurate fabrication of Cabinets, Panel Boards, Cubicles and Control Panels comes from years of experience in shearing bending, forming, welding and finishing all types of metals. Since 1882 Littleford has been serving industry in producing accurate fabrication.

These long years of producing fabricated products reflect in the finished unit. Littleford facilities are modern and afford an unprecedented standard of dependability and quality. If you have a problem involving accurate fabrication be assured Littleford skill and experience will produce the best possible product at low cost. Send blueprints today for an estimate. Remember there is no substitute for Litt'eford workmanship.



FABRICATORS OF PLATE AND SHEET METAL PRODUCTS FOR INDUSTRY SINCE 1882

LITTLEFORD

LITTLEFORD BROS., INC.
404 E. Pearl Street, Cincinnati 2, Ohio

For more information circle **65** on inquiry card.

NEW INSTRUMENTS

ence than by means of the conventional roller chart, permits immediate set-up as new tubes are brought out; "a low price never before reached in this class of instrument."—*Radio City Products Co., 152 W. 25th St., New York 7, N. Y.*

For more information circle **305** on inquiry card.

Phase Sequence Indicators

New "PSI" units combine functions of pilot light and phase sequence indicator for portable three-phase

equipment; insure proper rotation of blowers and motors in associated equipment without further checking. Available for 60 and 400 cps., 110, 220, or 440 v., with standard or dimmer type lenses. Special units available.—*Brunswick Instruments, P. O. Box 813, New Brunswick, N. J.*

For more information circle **306** on inquiry card.

Floor Conductance Tester

New "Model F Lite-Rite Floor & Equipment Tester," added to maker's line of static alarm devices, shows whether floors and equipment used in munitions plants, chemical plants, hospital, flour mills and other hazardous areas are conductive within the NFPA limits.—*The Hewson Co., Inc., 443 Broad St., Newark 2, N. J.*

For more information circle **307** on inquiry card.

Fuel Gage Tester

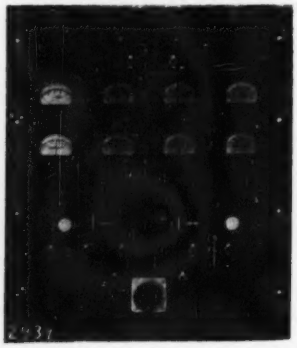
New "Type O-3 Aircraft Fuel Gage Tester," designed to test and calibrate aircraft capacitance type fuel gages, meets MIL-T-5911, is a direct-reading variable capacitor with a range of 50

to 6100 uuf. Accuracy is 0.1 percent and, through use of a main dial and a vernier dial, capacitance values in increments of 0.2 uuf are readily obtained. No external power source is required.—*Telectro Industries Corp., 35-18 37th St., Long Island City 1, N. Y.*

For more information circle **308** on inquiry card.

Instrument Calibrator

New "Model 500-A Calibration and Test Instrument Set" was developed to meet needs of calibrating and testing instruments using voltage-divider



type pickups; is particularly suitable for calibrating free and erecting type gyroscopes; adaptable to other types of instruments. Simultaneous calibration of four instruments is possible. Operates from 115 v.ac. and is built on standard 19-in. relay rack; incorporates a 28-v. power supply; has facilities for 400-cps. 3-phase external source to operate instrument motors; automatic timing device; elapsed-time meters.—*N.A.E.R. Corp., 2301 Purdue Ave., West Los Angeles 64, Calif.*

For more information circle **309** on inquiry card.

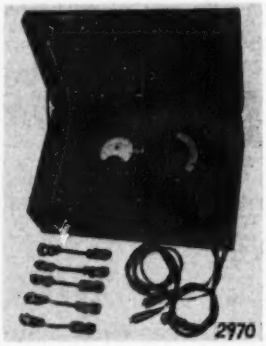
Insulation Test Set

New "Model 53 TAKK" 5000-v.dc. insulation test set combines in a 15-lb. instrument a 5000-v.dc. power supply and a microammeter, each of which can be used independently. Voltage range 0-5000 (continuous, variable); 5 current ranges: 0-0.1/-1/10/100/1000 ua.—*The Hewson Co., Inc., 443 Broad St., Newark 2, N. J.*

For more information circle **310** on inquiry card.

Aircraft-engine-temperature Indicator Tester

New "N-3 Aircraft Engine Temperature Indicator Tester" is designed to test and calibrate either single 12-v, 24-v, or dual 24-v ratio-meter



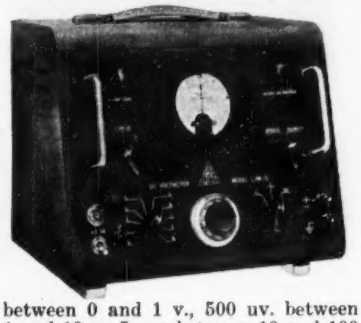
type temperature indicators, and single or dual thermocouple temperature indicators, working with Chromel-Alumel, iron-Constantan or copper-Constantan thermocouples; has met all requirements of MIL-T-7449A.—*Telectro Industries Corp., 35-18 37th St., Long Island City 1, N. Y.*

For more information circle **311** on inquiry card.

ELECTRICAL INSTRUMENTS

High-resolution Voltmeter

New "Model LVM-5" laboratory standard voltmeter uses null principle to achieve absolute accuracy of 0.1 percent of reading; resolution 50 uv.

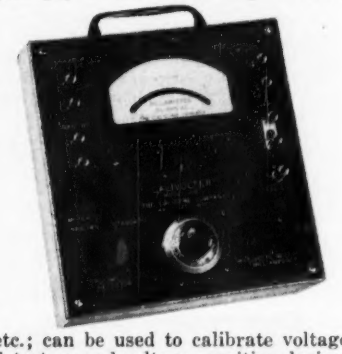


between 0 and 1 v., 500 uv. between 1 and 10 v., 5 mv. between 10 and 100 v.; linearity better than 0.05 percent; infinite input impedance.—*Computer Co. of America, Div. of Bruno-New York Industries Corp.*, 149 *Church St., New York 7, N. Y.*

For more information circle **312** on inquiry card.

Reference-voltage Source and Voltmeter

New "Model A-23 Calivolter" measures emf. of pressure and seismic pickups, strain measuring devices,



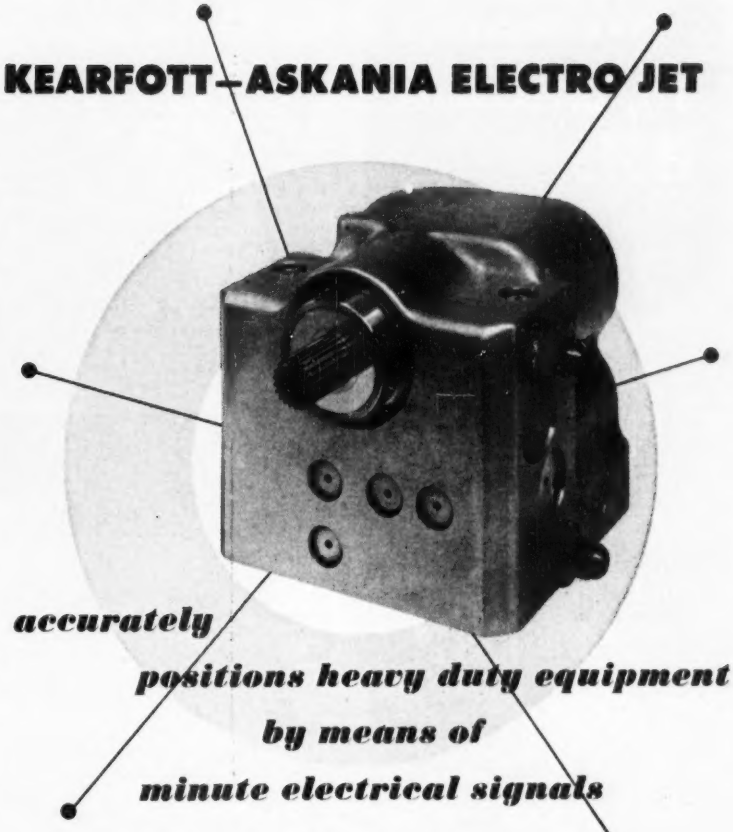
etc.; can be used to calibrate voltage detectors and voltage-sensitive devices including VTVMs, oscilloscopes and sensitive relays; for over-all calibrations of recording systems; and to measure frequency response of amplifiers, recording systems, etc.—*Calidyne Co., Winchester, Mass.*

For more information circle **313** on inquiry card.

Volt-ohm-milliammeter

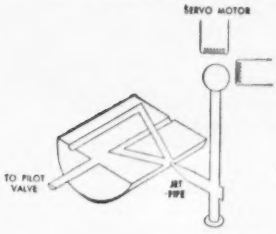
New "Model 480 AC-DC Multitester" features molded-in jacks flush with panel surface and molded-in battery holder with spring contact

KEARFOTT—ASKANIA ELECTRO JET



accurately positions heavy duty equipment by means of minute electrical signals

This Electro-Hydraulic Servo System is ideally suited for industrial controls to maintain flows, ratios, levels, pressures, speeds and for machine tool positioning. It is a 5¼" cube self-contained unit and weighs but 12 pounds.



The Kearfott Electro Jet utilized the Askania jet pipe principle, characterized by high frequency response, rugged construction and highly accurate shaft positioning. Rated output is 200 inch pounds torque through ±60 degrees. Maximum torque rating is 333 inch pounds. Frequency response is flat (within 3 db) up to 25 cycles. Resolution of the output piston positions is one part in 500 or better.

Write today for full information about the Kearfott Electro Jet. It may help in the solution of your control problem.

KEARFOTT COMPONENTS INCLUDE:

Gyros, Servo Motors, Synchros, Servo and Magnetic Amplifiers, Tachometer Generators, Hermetic Rotary Seals, Aircraft Navigational Systems, and other high accuracy mechanical, electrical and electronic components.

Send for Bulletin giving data of components of interest to you.

Kearfott
SINCE 1917

KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.

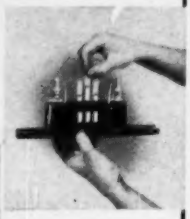
Sales and Engineering Offices: 1378 Main Avenue, Clifton, N. J.
Midwest Office: 188 W. Randolph Street, Chicago, Ill. South Central Office: 6115 Denton Drive, Dallas, Texas
West Coast Office: 253 N. Vinedo Avenue, Pasadena, Calif.

A GENERAL PRECISION EQUIPMENT CORPORATION SUBSIDIARY

For more information circle **66** on inquiry card.

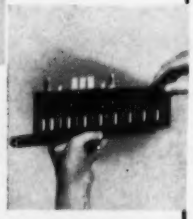
Make Accurate
pH, CHLORINE TESTS
this simple way

A. Fill three test tubes with sample to be tested and place them in base.



B. Add reagent to middle tube only.

C. Place color standard on base, move across until colors match and...



THERE'S THE VALUE *using*...

TAYLOR COMPARATORS
with
GUARANTEED COLOR STANDARDS

Taylor Comparators give you accurate pH, chlorine, phosphate or nitrate determinations . . . quickly . . . using these three simple steps. Best of all, Taylor Liquid Color Standards carry an unlimited guarantee against fading, thus, there's no chance of mechanical inaccuracy.

Taylor sets are lightweight, strong, and compact. You can carry them with you in the plant to avoid the annoyance of carrying test samples to the lab.

Many different slides can be used on the same base. All color standards for any one determination are housed in one slide . . . no fragile single standards to handle.

FREE HANDBOOK
"Modern pH and Chlorine Control" illustrates and describes complete Taylor line as well as theory and application of pH and chlorine control. Write for your copy. Or, see your dealer for Taylor sets.

W. A. TAYLOR AND CO.
416 RODGERS FORGE RD. • BALTIMORE, MD

For more information circle **67** on inquiry card.

NEW INSTRUMENTS

clips for immediate replacement without soldering or unsoldering; 800-microampere movement giving full 1000 ohm per volt sensitivity; circuit and range selection by means of both selector switch and jacks, providing maximum protection against burn-out and misuse; "new low price never before reached on this type of instrument."—*Radio City Products Co., Inc., Easton, Penna.*

For more information circle **314** on inquiry card.

Digital Voltmeters

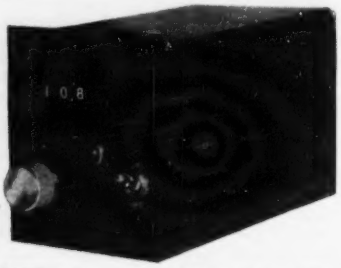
New digital voltmeters balance input against reference; are available in standard models with 2 to 5 in-line digits, ranges from 1 mv. to 1000 v.

with automatic ranging indicated by moving decimal point; input impedance 1000 megohms; accuracy, 1 digit; average time less than 1 sec. Models as specified to operate printers, electric typewriters or IBM punches.—*Electro-Instruments, Box S, Old San Diego Sta., San Diego* 10, *Calif.*

For more information circle **315** on inquiry card.

Digital Indicator

New "Miniature Numerical Indicator" is geared to a servomotor; can be installed long distances from



measuring point without lag difficulties; can be used to measure velocity, temperature load, light, length, and many other variables; can be used in conjunction with recorders.—*Streeter-Amet Co.* 4101 *Ravenswood Ave., Chicago* 13, *Ill.*

For more information circle **316** on inquiry card.

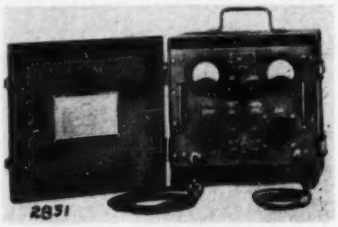
Pulse Generator

New "Model PG-200A," improved version of maker's pulse generator, is housed in new cabinet which provides greater cooling. Stability of instrument has been improved by utilization of components not commercially available at time of original design. Instrument generates adjustable rectangular waveforms having fast rise and decay times; provides wide ranges of pulse duration, amplitude, recurrence rate and positioning; may be operated self-synchronous or driven by an external signal of almost any waveform. In both cases, it furnishes a fast trigger for synchronizing auxiliary equipment.—*Teletronics Lab.*, 54 *Kinkel St., Westbury, L.I., N. Y.*

For more information circle **317** on inquiry card.

Broadband Power Meters

New broadband power meters offer complete coverage over frequency range of 20-10,000 Mc. for average



power levels of 20 microwatts to 5 watts. Both pulse and cw. power may be measured with a high accuracy. Instruments are direct-reading in average power; are suited to field or laboratory use.—*Bruno-New York Industries Corp.*, 460 *West* 34*th St., New York* 1, *N. Y.*

For more information circle **318** on inquiry card.

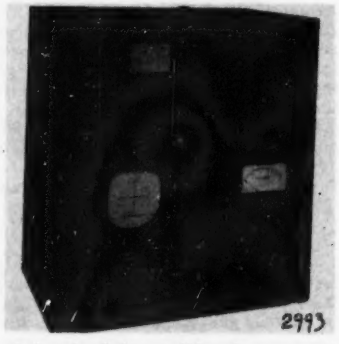
Carrier-system Voltmeter

New "Model 104" voltmeter, for installation and maintenance measurements on telephone, telegraph, telemetering and other carrier systems, covers 5-150-kc. frequency range, has 1-kc. frequency calibration accuracy. Signal measurement range is −80 to +42 dbm at 600 ohms impedance. Input impedance 10,000 ohms in the pass band, higher in rejection band. Unusually high selectivity; response down 3 db at 300 cps. off resonance, 45 db at 1,500 cps. off resonance. Reads direct in dbm; is designed for operation into an unbalanced 600-ohm line; may be converted quickly to balanced operation with maker's "Model 155 Line-Bridging Transformer."—*Sierra Electronic Corp., San Carlos* 2, *Calif.*

For more information circle **319** on inquiry card.

Microwave Spectrum Analyzer

New "FXR Spectrum Analyzer" provides push-pull deflection to both horizontal and vertical plates. Versatility is increased by interchangeable

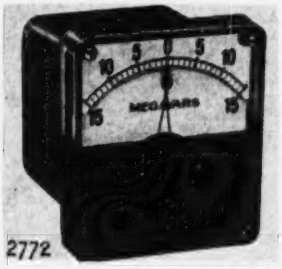


r-f. heads. I-f. amplifier has a center frequency of 20 Mc. Over-all gain of approx. 110 db is obtained with cascade input. Five-inch CRT has sweep rate of 10 to 20 cps. Frequency dispersion is 1 to 10 Mc./in. with viewable pulse lengths of 0.2 to 2.0 usec.—*Electronics & X-Ray Div., F-R Machine Works, Inc.*, 26-12 *Borough Place, Woodside* 77, *N. Y.*

For more information circle **320** on inquiry card.

Panel Instruments

New "Model 610 Group" 4½-in. switchboard and panel instruments have clear plastic fronts for maximum light on dial from sides, top

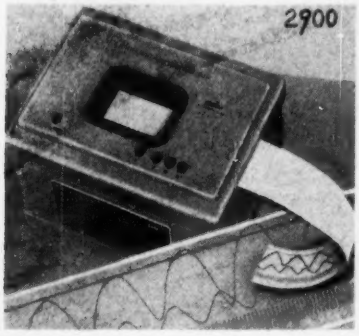


and front, thus obviate need for internal lumination under normal operating conditions. "In-line" pointer and dial eliminates parallax errors. Types and ranges to meet all switchboard and special requirements.—*Weston Electrical Instrument Corp.*, 614 *Frelinghuysen Ave., Newark 5, N. J.*

For more information circle **321** on inquiry card.

Rapid Recorder

New "Lumiscript Four-channel High-speed Photo Trace Recorder" features an almost pin-point light

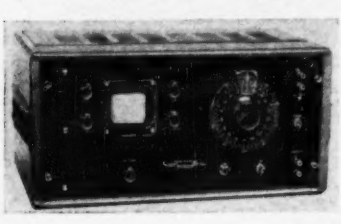


source (h-p. Hg), special-immediately-visible photographic paper, interchangeable electrical measuring systems (and availability of mechanical, pneumatic and hydraulic systems), push-button change of chart speeds, three chart widths with quick-change guide, etc. Instrument fills gap for recording minute currents or voltages "where standard recorder is too slow and oscillograph too expensive."—*Hartmann & Braun, Frankfurt am Main West 13, Germany.*

For more information circle **322** on inquiry card.

Ultrasonic Phase Standard

New "Type 706-A" generator provides two sinoidal voltage output signals whose phase relationship can be continuously controlled from 0 to 360 deg. with accuracy of 0.1 deg. Units



Circle **68** on inquiry card. ⟶

PANALARM "50"

OPENS THE DOOR

TO MORE DEPENDABLE ANNUNCIATOR PERFORMANCE

WITH NEW "INSTRUMENT-TYPE" CONSTRUCTION

LOOK inside the new Universal PANALARM "50". You will realize that here, at last, is an annunciator system built for *long term* dependability and service. Built to match the responsibility an annunciator must assume in your plant.

The PANALARM "50" Cabinet has a substantial hinged door . . . with sub-door to allow easy access to signal lamps. It has a new, rugged chassis design . . . pre-wired to handle any standard audio-visual signal requirement . . . and so flexible that signal sequences can be changed by simple terminal connections. No re-wiring is needed.

All moving parts and contacts of the PANALARM "50" are within hermetically sealed, plug-in units. They are corrosion-proof and suitable for Class I, Div. 2 locations. All connections are made to a single terminal block . . . with ample space for wiring.

SEND FOR COMPLETE 40-PAGE MANUAL

Ask for Catalog 100 1

PANALARM

PANALARM PRODUCTS, INC.

7405 N. Hamlin Ave., Skokie, Illinois

Copyright 1953 Panalarm Products, Inc.

PALMER
MERCURY ACTUATED

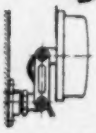
DIAL THERMOMETERS

in 3 types to suit any requirements

PATENTED

Full 4½" dial face. Stem can be placed at any angle and case can be rotated to any readable position.

1 Rigid Stem Dial Thermometer tapered bulb, interchangeable with standard industrial thermometer separable socket. (As illustrated above.)



2 Wall Mounted Dial Thermometer with flexible connecting armor. Case adjustable to easy reading position.

3 Flush Mounted Dial Thermometer for panel mounting with flexible connecting armor.

All three types have a full 4½" dial face.

for accuracy: Mercury actuated . . . Fully Compensated by Invar Compensator. Guaranteed Accurate 1 scale division.

for angularity: Can be adjusted to most readable position at any angle desired.

for readability: Bold Black Numbers . . . 11" of scale Reading Dial face can always be placed in easiest readable position.

for interchangeability: Always specify "PALMER" Separable sockets as they are interchangeable for Dial or Industrial type Thermometers.

Write for Catalog Information

PALMER
THERMOMETERS, INC.
[illegible] Ave., Cincinnati 12, Ohio
Mfrs. of Industrial Laboratory, Recording and Dial Thermometers

For more information circle **69** on inquiry card.

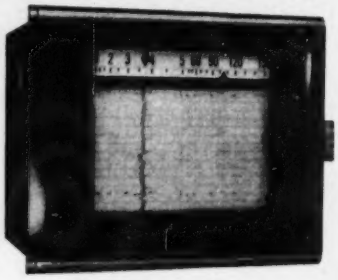
NEW INSTRUMENTS

can be furnished to supply any single specified output frequency between 20 and 200 kc. —*Technology Instrument Corp., Acton, Mass.*

For more information circle **323** on inquiry card.

Combination Voltmeter and Ammeter Recorder

New "Dynamaster" measures and records both current and voltage simultaneously on one chart. Its primary measuring elements are a thermal-voltage converter and a thermal-current converter. Overall accuracy is



within 1 percent and sensitivity 0.05 percent. Half of two-zone chart is used for recording amperes, the other half for volts. Calibrations follow square law, giving expanded graduations in normally-used sections of ranges. Chart speeds from ¾ iph. to 4 ips. through easily changed gears. Pen speeds as fast as 1½ second for full-scale travel.—*The Bristol Co., Waterbury 20, Conn.*

For more information circle **324** on inquiry card.

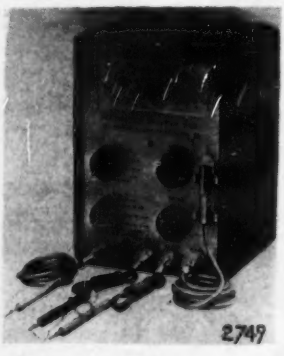
Oscilloscope

New "Model 600" is claimed to contain "the same precision features as other scopes selling up to twice its new low price" [of under a hundred dollars]. It uses new "5UP1" 5-in. tube; retrace blanking amplifier; 2-step compensated attenuator input; 2-stage push-pull vertical amplifier with sensitivity of 0.02 v./in.—*Electronic Measurements Corp., 280 Lafayette St., New York 12, N. Y.*

For more information circle **325** on inquiry card.

VTVM

New "302 Polymeter" features subminiature vacuum-tube RF probe, lighted 7-in. scale, and maker's exclusive linearity circuit. It reads d-c. and peak-to-peak voltages from 200



mv. to 2,800 v.; has seven other a-c. and d-c. voltage, resistance and db ranges.—*Sylvania Electric Products Inc., 1221 W. Third St., Williamsport, Pa.*

For more information circle **326** on inquiry card.

Sweep Generator

New "WR-86A" wide-range sweep generator, for use in designing, testing, and servicing UHF TV equipment, is engineered for requirements of both color and black-and-white receivers, tuners, and converters. It supersedes maker's two laboratory-type UHF sweep generators.—*Radio Corp. of America, Harrison, N. J.*

For more information circle **327** on inquiry card.

ELECTRICAL-INSTRUMENT ACCESSORIES

Precision Ratio Sets

New "PT Series Standard Ratio Transformers" are high-precision (0.00001 resolution) autotransformers and a-c. voltage dividers for ac-

curately measuring and generating a-c. voltage ratios. Series comprises three units: "PT-1" (illustrated) covers 50-to-10,000-cps. frequency range with limited input voltages at low frequencies; uses push-button selection for first three digits and a 10-turn voltage-dividing resistor for remainder. "PT-2" covers same frequency and voltage ranges but VDR is replaced by two push-button decades, making five decades. "PT-3" uses five push-button decades but is designed for higher voltage inputs at low frequencies.—*Gertsch Products, Inc., 11846 Mississippi Ave., Los Angeles 25, Calif.*

For more information circle **328** on inquiry card.

30-Mc. Attenuator

New "Type 30" attenuator, for use as a linear standard of attenuation in frequency range 25 to 35 Mc., has attenuation continuously variable over

a range of 80 db above a minimum insertion loss of 25 db. A counter-type indicator, calibrated in tenths of a db, reads attenuation directly with an accuracy of 0.2 db.—*Airborne Instruments Laboratory, Inc., 160 Old Country Rd., Mineola, N. Y.*

For more information circle **329** on inquiry card.

High-voltage Probe

New 40,000-volt high-voltage probe is available as an accessory item for maker's "Model 262" volt-ohm milliammeter and "Model 269" volt-ohm-microammeter.—*Simpson Electric Co., 5200 W. Kinzie St., Chicago 44, Ill.*

For more information circle **330** on inquiry card.

Variable Autotransformer

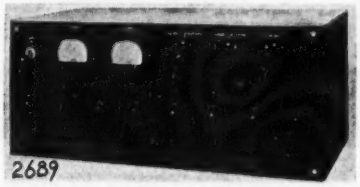
New "Model PA-3," added to "Adjust-A-Volt" line, is a low-cost variable transformer adaptable for work

bench, line voltage control for power supplies and instruments, control of heat, motor speeds, light intensity, etc. Maximum load rating 0.4 kva. Maximum output current 3 amps.—*The Standard Electrical Products Co., 2240 E. Third St., Dayton, Ohio.*

For more information circle **331** on inquiry card.

Multi-channel Bridge Balance Unit

New "Type S-2 D-C Bridge Balance" simplifies oscillographic recording of low-frequency or steady-state conditions; is used as an inter-

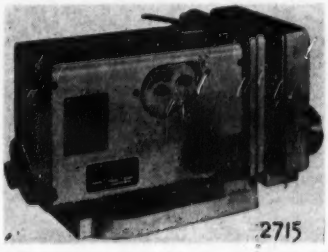


mediate unit between high-sensitivity oscillographic galvanometers and resistance-type pickups; contains all controls and indicators for adjustment and calibration of up to eight data channels.—*Wm. Miller Instruments, Inc., 325 N. Halstead Avenue, Pasadena 8, Calif.*

For more information circle **332** on inquiry card.

Oscilloscope Camera

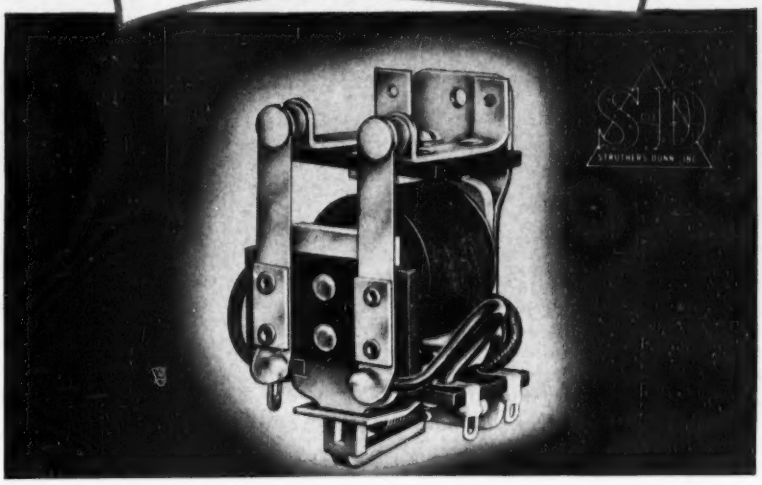
New "Varitron DR-2AB," electric camera for oscilloscope trace recording and high speed instrumentation of data panels, features motor-driven



continuous-motion film magazine with capacity of 100 ft. of daylight-loading 35-mm. film or 200 ft. of darkroom-loading 35-mm. film. The drive is electro-mechanical. Electric governor

STRUTHERS -DUNN

5,348 RELAY TYPES



New! LOW COST 15-AMPERE RELAY

. . . This new 215-Frame Struthers-Dunn relay is specifically designed for today's "cost conscious" engineering . . . and it's backed by full S-D quality and dependability.

Write for S-D Relay Data Bulletin 2215

SPECIFICATIONS

RATINGS: 15 amperes at 115 volts AC or low-voltage DC.

CONTACTS: Single- and double-pole; single- and double-throw.

COILS: AC to 230 volts; DC to 115 volts.

SENSITIVITY: Normal AC, 3 va.; minimum AC, 0.5 va.; normal DC, 2 watts; minimum DC, 0.1 watts.

GET THIS QUICK GUIDE... to the most popular of the S-D 5,348 relay types

STRUTHERS-DUNN, Inc.,
Pitman, N. J.

Without obligation send the 20-page "Quick Guide" to S-D relays and timers.

Name .....

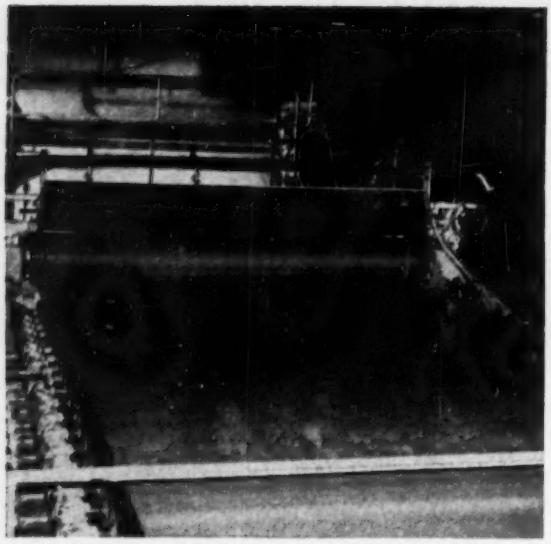
Position .....

Company .....

Address .....

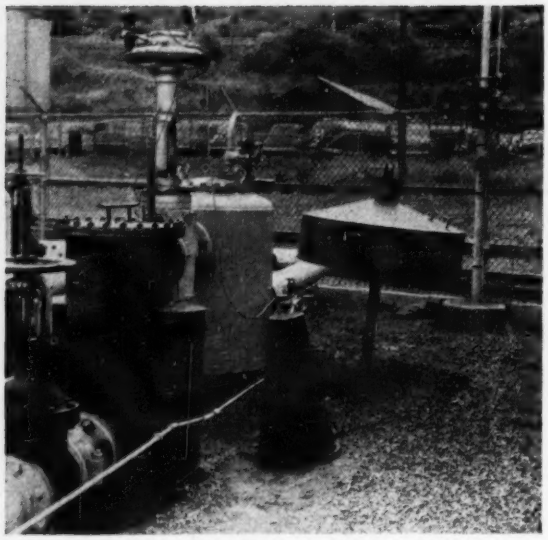
SALES ENGINEERING OFFICES IN: ATLANTA • BALTIMORE • BOSTON • BUFFALO • CHARLOTTE • CHICAGO CINCINNATI • CLEVELAND • DALLAS • DETROIT • KANSAS CITY • LOS ANGELES • MINNEAPOLIS • MONTREAL NEW ORLEANS • NEW YORK • PITTSBURGH • ST. LOUIS • SAN FRANCISCO • SEATTLE • SYRACUSE • TORONTO

For more information circle **70** on inquiry card.



FLUCTUATIONS IN VACUUM LINES *are sensed by a Honeywell mercury switch Vacuumstat which controls intermittent water spray on a paper machine Fourdrinier section. Costly continuous shower is thus eliminated at the Combined Locks Paper Co., Little Chute, Wis.*

Control equipment cost—$23.00*

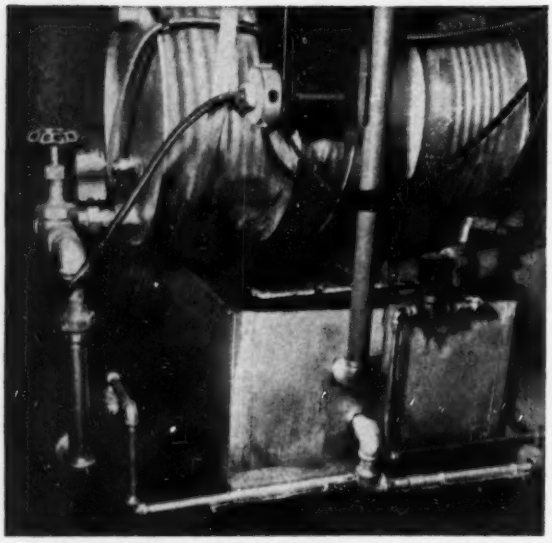


NO MORE RUPTURED STRAINERS *at the General Petroleum Corp. terminal in Portland, Ore., since a Honeywell Differential Pressure Controller was installed to warn of excessive scale load. Plant costs are greatly reduced because oil strainer replacements are eliminated.*

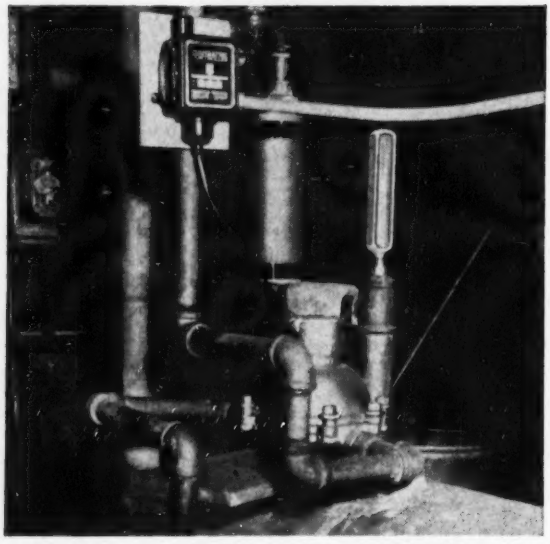
Control equipment cost—$55.00*

Honeywell

Industrial Controls



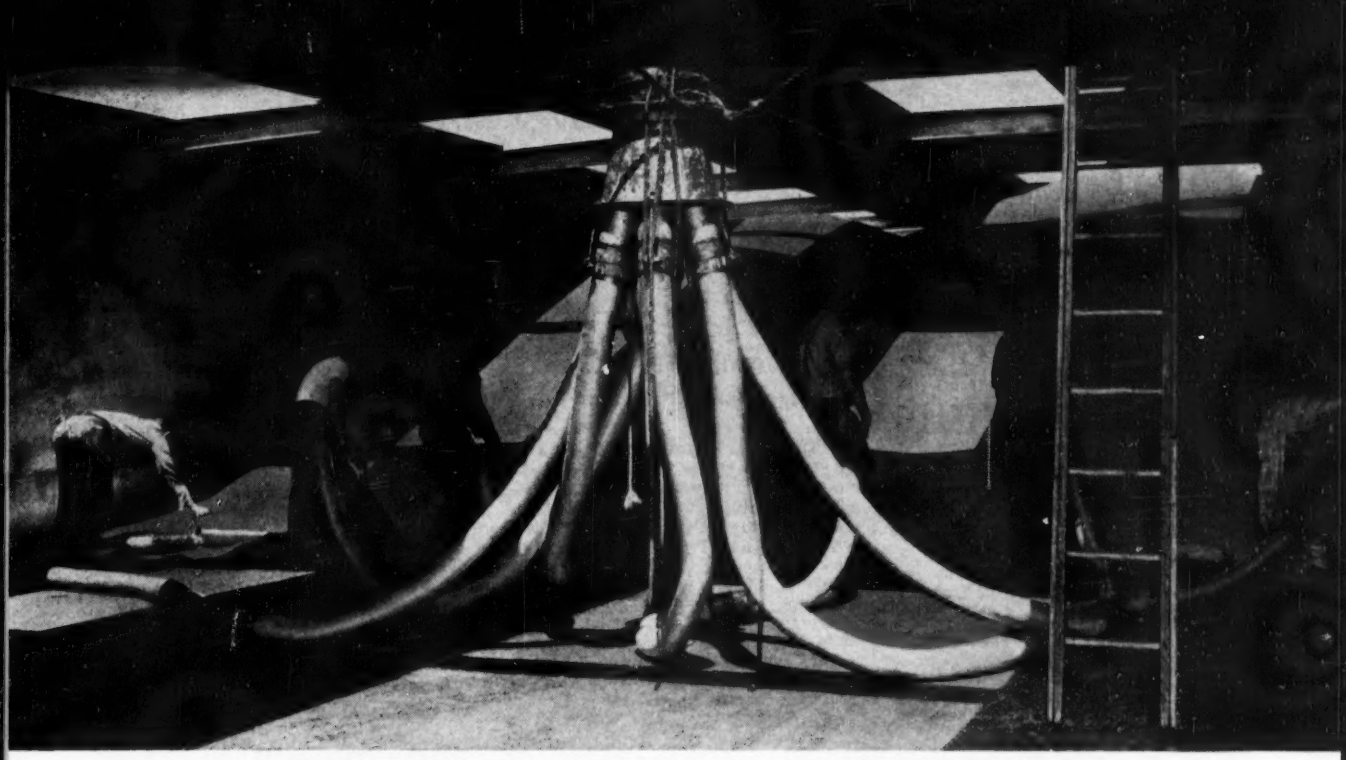
RECIRCULATION OF TREATED COOLING WATER, *after it has become heated, is facilitated by a Honeywell immersion type Aquastat Controller. At the Atwood Vacuum Machine Co., Rockford, Ill. it is used in a homemade cooling unit for a high frequency converter.* **Control equipment cost—$12.50***



STEAM COSTS ARE REDUCED *at the Spaulding-Moss Co., Boston, Mass. by the daytime storage of steam-heated water for after-hour use. A Honeywell Aquastat Controller here regulates steam in the hot water tank.*

Control equipment cost—$12.50*

For more information circle **71** on inquiry card.



SUCTION HOSE LINES CAN'T PLUG UP *and cause expensive delays when vacuum and line loads are regulated by Honeywell Controls. Here the Oregon Commission of Public Docks keeps grain ship unloading running smoothly with Honeywell Industrial Motor, Relay and Pressuretrol.*
Control equipment cost—$174.25*

Reduce costs

THOSE who know that attention to costs is smart business have often found the answer to their cost reduction problems in the surprisingly inexpensive use of simplified controls.

In the shipping industry, for example, cost-paring Honeywell Controls speed grain ship unloading—frequently to the extent of permitting an extra cargo trip each year.

Hundreds of Honeywell Industrial Controls serve an expanding variety of needs—whether they be the preventing of production tie-ups . . . freeing of experienced personnel for more responsible duties . . . avoiding waste and rejects . . . conserving of processing or treating agents.

Low-cost Honeywell Controls are as uncomplicated in operation as in construction . . . designed to do a specific job effectively, inexpensively.

Throughout your plant there are many opportunities for Honeywell Controls to save you money . . . as well as speed production, lower maintenance, increase quality.

Your nearby Honeywell sales engineer will welcome the occasion to discuss how you can reduce costs through the use of these controls. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa. *Also manufacturers of a complete line of precision measuring, recording and controlling instruments.*

**List Price — subject to change without notice*

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

For more information circle **71** on inquiry card.

SCAM: FIRST

with these broad and basic developments in the ANNUNCIATOR FIELD!

FIRST AUTOMATICALLY AND CONTINUOUSLY SELF-SUPERVISED CIRCUIT.

With the DE Line, Scam pioneered the development of self-policing alarms with many new and versatile features. Each standard Plug-In operates from either NO or NC field signals . . . each has a simple lock-in for momentary alarms . . . each has an auxiliary contact for remote indication either NO or NC. Scam Special Plug-Ins provide HI-LO Level indication and sequential signals.

FIRST WITH STANDARD, COMPACT CABINET DESIGN.

Scam single-three-five-seven or eleven-unit cabinets require the least panel area and may be arranged in a variety of ways to provide maximum utility. Any Scam plug-in —special or standard—fits into the Cabinets without any chassis wiring changes.

FIRST TO OFFER AN ECONOMICAL, COMPACT, SINGLE-DUTY, SELF-MONITORING ALARM.

The Fail Safe *Econ Line* made possible positive identification of trouble sources and offered industry an opportunity to extend alarm usage on an economical and practical basis.

For the complete story of Scam please mail the coupon.

Scam circuits patent pending.

Mail Today! Mail Today!

SCAM INSTRUMENT CORPORATION

SCAM INSTRUMENT CORPORATION
3909 W. Irving Park, Chicago 18, Illinois

Send complete literature on the SCAM line.

NAME_____

POSITION_____

ADDRESS_____

CITY_____ STATE_____

For more information circle **72** on inquiry card.

NEW INSTRUMENTS

gives three speeds: 60, 48, and 36 ips. Mechanical transmission gives 8 reduced speeds. Speed accuracy is 1 percent. Single-frame still pictures are possible.—*Photographic Products Inc., 1000 N. Olive St., Anaheim, Calif.*

For more information circle **333** on inquiry card.

AMPLIFIERS

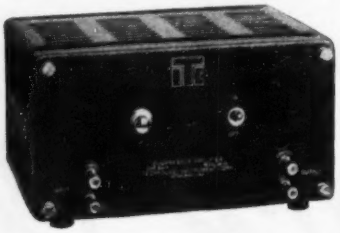
Magnetic Amplifiers

New "RG-60-D Series" magnetic amplifiers, in hermetically-sealed cases, have three control windings, one of which may be used to provide a lead (anticipation) signal when fed from a conventional differentiating network. The other control winding may be used to provide a positive feedback signal to compensate for load line voltage drop. Three models provide maximum d-c. output current of 4.5, 1.2 and 0.225 amps.; mean output voltage of 6, 27 and 115. Size 4 5/16 x 3 11/16 x 4½ in. high. Weight 2 lb. 3 oz.—*Atlas Engineering Co., Roxbury, Mass.*

For more information circle **334** on inquiry card.

Compressor Amplifier

New "Type 501-A," said to be ideal for stabilizing varying signals, accepts input signals of variable amplitude between 1.25 and 50 v. and delivers an output signal of same waveform but held at substantially constant amplitude of 0.25 v. by a servo-controlled distortionless variable attenuator. Compression ratio is 40 to 1 (32db) from 500 cps. to 1 Mc., slightly less below 500 cps. Closed loop returns output level to 0.25 v. within 0.1 sec. after 20-db step-function increase in input.—*Technology Instrument Corp., Acton, Mass.*



For more information circle **335** on inquiry card.

Amplifiers

New "Model BL-520 Universal Amplifier" high-gain carrier amplifier accepts signals from both resistive and inductive pickups for recording on a direct-writing oscillograph. Maximum sensitivity equivalent to 0.5 uv. per chart millimeter. ★ New "Model BL-530 Dual Channel D.C. Amplifier" will accept both single-ended and differential signals with a 50-mv. sensitivity; provides for accurate calibration of recorded signals.—*Brush Electronics Co., Equipment Dep't RT-4, 3405 Perkins Avenue, Cleveland, 14, Ohio.*

For more information circle **336** on inquiry card.

Hi-fi Amplifier Kits

Four new amplifier kits for hi-fi reproduction cover range from 10 to 40 watts: "HF-12" 10 watts, "HF-18 Williamson" type all-triode amplifier 16.5 watts, and "HF-40 Auditorium" amplifier 40-55 watts. Also "HF-3" preamplifier, featuring complete record equalizer and new tone control. Kits include all necessary transformers, chokes, sectional chassis and complete instructions including photographs, drawings and decals.—*Triad Transformer Corp., 4055 Redwood Ave., Venice, Calif.*

For more information circle **337** on inquiry card.

POWER SUPPLIES

Heavy-duty D-c. Supply

New "Model 306" delivers high-current (25-60 ma.) high-voltage (2950-3750 v.) power for microwave and nuclear applications. Stability and regulation are said to be "unmatched by any comparable unit now commercially available." Regulation 0.5 percent, ripple 50 mv.—*Allied Engineering Div., Allied International Inc., South Norwalk, Conn.*

For more information circle **338** on inquiry card.

D-c. Power Supply

New automatic selenium rectifier for heavy-duty production testing offers advantage of automatic circuits which are completely magnetic, with no electronic components; has adjustable output from 3 to 15 v.dc., 25 to 120 amps., filtered to 1 percent rms. ripple; automatic constant voltage to 1 percent; automatic correction of 5 percent for fluctuations of a-c. input (220 v., 3-phase, 60 cps.).—*Richardson-Allen Corp., 116-15 Fifteenth Avenue, College Point, N. Y.*

For more information circle **339** on inquiry card.

Mag-amp.-reg. Supplies

New magnetic-amplifer controlled power supplies contain no moving parts or tubes, require no warm-up time; are suitable for servo-mechanisms, computer power supplies and heavy-duty sources of 28.5 v.dc. Available current outputs 5, 10, 50, 100, 200, 500 amps. Special units for other voltages and for constant current.—*Mag-Electric Products, Inc., 12822 Yukon Ave., Hawthorne, Calif.*

For more information circle **340** on inquiry card.

Constant-current or -voltage Supply

New "Model PS-110," primarily intended for use with semi-conductors, also affords maximum protection against excessive currents for instrument calibration and measurements of non-linear devices. Two unique features: (1) Current and voltage may be varied from plus to minus continuously through 0 without necessity for polarity switching; (2) instrument can control extremely small currents (considerably less than 1 microamp.). Seven current ranges from 50 μa. to 50 ma. at maximum load voltage of 100 v.; three voltage ranges 200 v. to 10 v. at maximum current of 50 ma. Regulation with load changes, better than 0.25 percent.—*Teletronics Lab., Inc., 54 Kinkel St., Westbury, L.I., N.Y.*

For more information circle **341** on inquiry card.

ELECTRICAL and ELECTRONIC COMPONENTS

Miniature Resolver

New "Size 15 Telesyn Resolver" weighs 5 oz.; continuously resolves input voltages in sine and cosine components.—*Ford Instrument Co., 31-10 Thomson Ave., Long Island City 1, N. Y.*

For more information circle **342** on inquiry card.

Miniature Pentode

New "404A" 9-pin miniature pentode for communications systems features extremely long operating life, achieved by "Polioptic" manufacturing process which prevents contamination of tube elements during processing. In this process, the chamfered button stem and tube envelope are optically polished; form a good seal when joined. Stem may be finally sealed to envelope at a much lower temperature than usual and no significant oxidation of tube elements occurs.—*American Radio Company, Dept. 130, 445 Park Ave., New York 22, N. Y.*

For more information circle **343** on inquiry card.

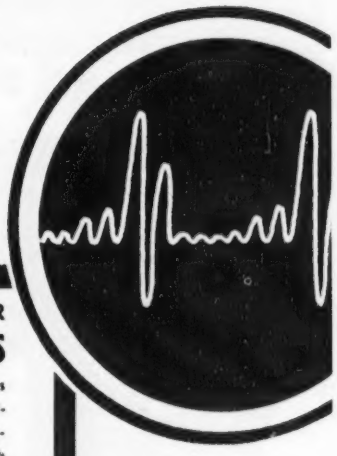
Temperature-limited Diodes

New "2AC-15 and 8DC-15 Kalotron" diodes are announced. "2AC-15" has cathode voltage 1.8 dc/ac, cathode current 310-335 ma, plate voltage 500, plate current 0.410-0.550 ma; "8DC-15" has cathode voltage 5.6 ac/dc, cathode current 55-75 ma, plate voltage 500, plate current 0.450-0.575 ma. Both use T951 bulbs and 8537 intermediate octal bases; have temperature limited emission characteristics where anode current is a direct function of filament voltage. "2AC-15" has maker's feature by which filament failure causes closing of external high-impedance circuit.—*Thermosen, Inc., 361 West Main St., Stamford, Conn.*

For more information circle **344** on inquiry card.

UHF Power Triode

New "6383" "flyweight" (8-oz.) power triode features high power output at ultra-high frequencies; has maximum plate dissipation of 600 watts; can be operated with full plate voltage and plate input at frequencies



SPECIAL OPPORTUNITIES FOR
ELECTRONIC ENGINEERS

Convair in beautiful, sunshiny San Diego invites you to join an "engineers" engineering department. Interesting, challenging, essential long-range projects in missiles, engineering research and electronics development. Positions open in these specialized fields:

Microwave Antennae	Dynamics Testing
Microwave Components	Telemetering
Electronic Packaging	Servomechanisms
Mathematical Physics	Electron Tubes
Electronic Components	Radome Design
Electronic Systems	Digital Computers
Applied Mathematics	Test Equipment
Transmitters & Receivers	Miniature Circuits

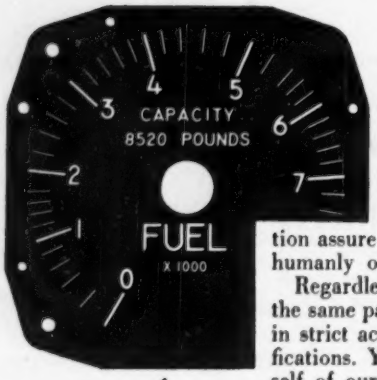
Generous travel allowances to those accepted. For free brochure, write Mr. H. T. Brooks, Engineering Dept. I-9.

CONVAIR
IN BEAUTIFUL
SAN DIEGO
Division of General Dynamics
3302 PACIFIC HIWAY
SAN DIEGO 12, CALIFORNIA

For more information circle **73** on inquiry card.

Where the INFINITESIMAL .001" is IMPORTANT

AS IN INSTRUMENT DIALS



"MICROSCOPIC-PRECISION" actually defines the minute accuracy of dials *by U. S. Radium* (instrument, clock, or watch), for "microscopic" checks and painstaking inspections in every step of production assure the *highest degree of perfection* humanly or mechanically possible.

Regardless of size of the order, we take the same pains to assure a finished product in strict accordance with prints and specifications. You are welcome to avail yourself of our engineering and designing experience toward the end that your product may be both *functionally satisfactory* and *less costly* in production.

where FUNCTIONAL DESIGN *is IMPORTANT* AS IN INSTRUMENT PANELS

Special equipment and specialized personnel, plus our rigid controls, constant checking and inspection guarantee the fine finished product your order merits. Whether flat or curved, we can produce your panels edge-lighted, and either luminous or non-luminous engraved, etched, screened or lithographed, with the *ultimate in uniformity* and *legibility*.

where APPEARANCE AND ECONOMY are *IMPORTANT* — AS IN NAMEPLATES

The same engineering skill and same plant facilities are yours for the production of nameplates. For years we have been the major source of supply for many industries and our reputation has been built on *attention to detail, prompt deliveries,* and the *economy* effected for our customers.

***FOR COMPLETE INFORMATION** on items of interest to you, address — United States Radium Corporation, 535 Pearl St., New York 7, N. Y. attention Dept. I-9.*

U·S RADIUM

For more information circle **74** on inquiry card.

up to 2000 Mc.; is designed for both liquid and forced-air cooling. Coaxial electrode structure permits effective isolation of plate from cathode; makes tube particularly suitable for cathode-drive circuits.—*Tube Div., RCA, Harrison, N. J.*

For more information circle **345** on inquiry card.

Photocell "Sun Battery"

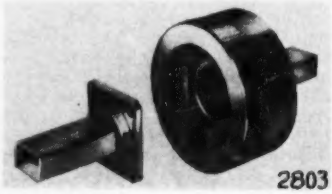
New "B2M" low-cost mounted selenium photocell designed for engineers and experimenters but suitable

for practical use measures 23/32 by 7/16 in. (active area 0.26 sq. in.) yet it generates about 60 microamperes at 100 foot-candles; can be used as a "sun battery" power supply for transistorized and portable devices.—*International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.*

For more information circle **346** on inquiry card.

Waveguide Disconnect

New waveguide quick disconnect provides a reliable method of rapidly making and breaking waveguide connections without tools; is also suited

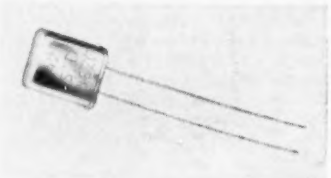


for incorporation in microwave test sets; is available to fit standard chokes and flanges of RG-51/U, RG-52/U and RG-91/U waveguide.—*Aircraft Armaments, Inc., P. O. Box 1777, Baltimore 3, Md.*

For more information circle **347** on inquiry card.

Subminiature Piezo Crystal

New "Type 42" subminiature plated quartz crystals for frequency control of aircraft transmitters and receivers



are designed for switch deck mounting; are available for all frequencies from 15 to 100 Mc.; resist high shock and vibration; are hermetically sealed in a nickel-plated copper container filled with dry nitrogen.—*Standard Piezo Co., Carlisle, Penna.*

For more information circle **348** on inquiry card.

Flat "Pan" Capacitors

New "Flat Pan Ceramic Capacitors" simplify design of VHF bypass circuits; consist of one to four sections

in a shallow metal pan filled with phenolic resin; available voltage ratings from 100 to 500 v.dc. and various capacitances.—*Sprague Electric Co., 43 Marshall St., North Adams, Mass.*

For more information circle **349** on inquiry card.

Sealed Pulse Transformer

New "Type PT-4" hermetically-sealed pulse transformer is a four-winding unit with 2:2:1:1 turns ratios. Measured characteristics include 120 ohms characteristic impedance, 0.03 usec. rise time, 20 percent droop at 1 usec., 40 percent droop at 2 usec. Versatility: As a pulse or trigger generator, it may be used in various blocking oscillator circuits; may also be used for coupling, impedance matching, etc.—*Berkshire Laboratories, 508 Beaver Pond Rd., Lincoln, Mass.*

For more information circle **350** on inquiry card.

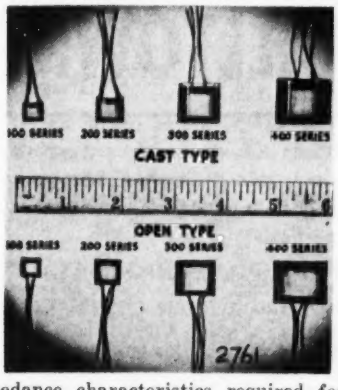
Miniature Transformers

New line of miniature transformers comprises units with outputs of 3 va. and 6 va. Illustrated is "TW-6," 1 in. O.D. x ¾ in. high, weight 1½ oz. Input 115 v. 400 cps.; output 6 va.; heat rise 40 C. Class "A"; hermetically sealed in metal case to MIL-T-27 requirements.—*Torwico Electronics, Inc., 961 Frelinghuysen Avenue, Newark 5, N. Y.*

For more information circle **351** on inquiry card.

Subminiature Transformers

New 32-model line of subminiature transformers is especially designed for transistor and other miniaturized circuit application. Because of impedance characteristics required for transistor use, as many as 6800 turns (400 ft.) of wire must be wound on



MINIATURIZING YOUR EQUIPMENT?

Specify SIMPLEST, MOST COMPACT

AMPERITE THERMOSTATIC DELAY RELAYS

MOST ECONOMICAL, HERMETICALLY SEALED

STANDARD

MINIATURE

Provide delays ranging from 2 to 120 seconds.

- Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.
- *Hermetically sealed.* Not affected by altitude, moisture, or other climate changes.
- Circuits: *SPST only* — normally open or normally closed.

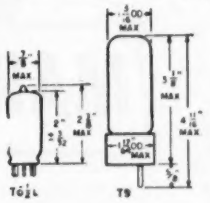
Amperite Thermostatic Delay Relays are compensated for ambient temperature changes from —55° to +70°C. Heaters consume approximately 2 W. and may be operated continuously. The units are *most compact, rugged, explosion-proof, long-lived,* and — *inexpensive!*

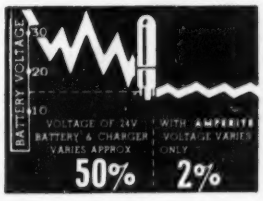
TYPES: Standard Radio Octal, and 9-Pin Miniature.

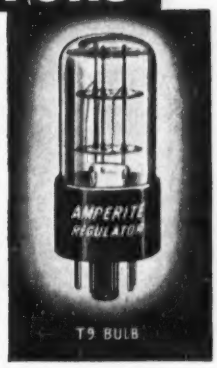
PROBLEM? Send for Bulletin No. TR-81

BALLAST-REGULATORS

- **Amperite Regulators are designed to keep the current in a circuit *automatically regulated* at a definite value (for example, 0.5 amp).**
- **For currents of 60 ma. to 5 amps. *Operates on A.C., D.C., Pulsating Current.***
- **Hermetically sealed, light, compact, and most inexpensive.**







Maximum Wattage Dissipation: T6½L—5W. T9—10W.

Amperite Regulators are the simplest, most effective method for obtaining *automatic regulation* of current or voltage. *Hermetically sealed,* they are not affected by changes in altitude, ambient temperature (—55° to +90°C), or humidity. Rugged; no moving parts; changed as easily as a radio tube.

Write for 4-page Technical Bulletin No. AB-51

AMPERITE CO. Inc., 561 Broadway, New York 12, N. Y.

In Canada: Atlas Radio Corp., Ltd., 560 King St. W., Toronto 2B

For more information circle **75** on inquiry card.

nylon bobbins. Temperature range −25 C. to 100 C. Cast (encapsulated) models are particularly resistant to moisture and other contaminants; open types are protected by a resin coating.—*Texas Instruments Inc., 6000 Lemmon Ave., Dallas 9, Tex.*

For more information circle **352** on inquiry card.

Encapsulated Resistor

New "Type 38042" encapsulated resistor has wire-wound element is precisely positioned in epoxy body. Unit itself is mounted directly on chassis with two 8-32 machine screws. Terminals are turret type. Resistance values 0.1 ohm to 3 megohms.—*Cinema Engineering Co. Division Aerovox, Burbank, Calif.*

For more information circle **353** on inquiry card.

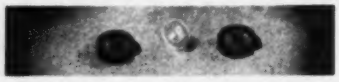
Trimmer VDRs

New "Type RFT Metlfilm Trimmer Potentiometers" feature tough smooth film deposited-metal resistance element exhibiting excellent noise and wear characteristics. All of available resistance variation is contacted with about 25 turns of adjusting screw. Thus a 90-deg. turn of screw results in a change of about 1 percent of applied voltage. Miniature size: suitable for trimming adjustments in high-component-density equipment: units may be stacked with up to seven per square inch of panel area.—*Technology Instrument Corp., Acton, Mass.*

For more information circle **354** on inquiry card.

Miniature Ferrite Pot Core

New "Part 7F160" miniature pot core made of "Ferroxcube Type 3C" ferrite material permits construction of extremely small coil assemblies



having moderate inductance values with a relatively high *Q*. Assemblies may be placed close together with negligible coupling.—*Sprague Electric Co., North Adams, Mass.*

For more information circle **355** on inquiry card.

High-temperature Resistors

New "Rhom-Ized" is said to be "a revolutionary type precision wire wound resistor, which for the very first time gives the industry a highly

stabilized resistor completely impervious to salt water and humidity under all climatic conditions." Wire resistance elements and conjunctions are completely suspended in Silastic and then encapsulated in a non-hygroscopic resin. Silastic will withstand temperatures to 500 F.; has high dielectric strength; is weather-proof, water-proof and freeze-proof. Its high heat conductivity lowers hot-spot temperature rises.—*RHO Engineering Co., 4205 Sepulveda Blvd., Culver City, Calif.*

For more information circle **356** on inquiry card.

Hermetically-sealed Coils

New series of hermetically-sealed coils are offered in a wide range of electrical and mechanical characteristics. Features include true glass-to-metal sealing; insulated metal case; meet and exceed most rigid requirements.—*Fugle-Miller Laboratories, 398 Main St., Metuchen, N. J.*

For more information circle **357** on inquiry card.

Audio Variable Delay

New "Echo-Vox" is a variable time delay at audio frequencies for proper phasing of speakers in auditoriums. However, opposite effect may be obtained where introduction of a slight echo would enhance acoustical properties of area.—*Kay Electric Co., 14 Maple Ave., Pine Brook, N. J.*

For more information circle **358** on inquiry card.

Resistors for Automation

New "PW" resistors are designed especially for printed wiring assembly technique and automation; are encapsulated in epoxy; meet require-

ments of humidity protection and aging presently met only by resistors

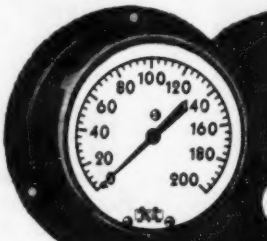
Take surface temperatures quickly, accurately... with the

Pyrocon

The handy Alnor Pyrocon is unequaled for quick, accurate reading of all surface temperatures . . . whether surfaces are metallic or non-metallic, flat or curved. Accurate temperatures are easily understood on the Pyrocon's direct reading scale face . . . without interpolation or need of conversion tables. A wide selection of thermocouples and extension arms permits adaptation to many types of service. For complete details and prices, send for Bulletin No. 4257. Illinois Testing Laboratories Inc., Room 518, 420 N. LaSalle Street, Chicago 10, Ill.

Alnor PRECISION INSTRUMENTS FOR EVERY INDUSTRY

For more information circle **76** on inquiry card.



THE Right GAUGE FOR YOUR SPECIFIC NEEDS

MARSHALLTOWN

• Available in a wide variety of general purpose and special purpose gauges in pressure ranges to meet your specifications in every particular.

WRITE TODAY FOR COMPLETE INFORMATION.

PRESSURE, VACUUM, COMPOUND, ALTITUDE, COMBINATION, DIAPHRAGM, HYDRAULIC, AND SPECIAL PURPOSE GAUGES, DIAL THERMOMETERS, (VAPOR TENSION OR BI-METAL)

MARSHALLTOWN MFG. CO.

800 EAST NEVADA ST. • MARSHALLTOWN 3, IOWA

For more information circle **77** on inquiry card.

Don't Take A Chance

where your sales promotion is concerned.

Your advertising in the November 1954 issue of **Instruments and Automation** just can't miss hitting its target.

November I&A will present the complete descriptive directory of exhibitors and products for automatic production to be shown at the First International Automation Exposition.

Received by its 18,000 subscribers two weeks **before** the show, I&A will figure prominently in subscribers' plans for attending.

Also of top interest will be the complete report on the new and outstanding devices revealed during the September Instrument Exposition.

So draw your bow, take aim, and let fly. Whether your target be the buyers and users in the "new" field of Automation, or its twin, Measurement and Control, you'll score more bulls-eyes through advertising in **Instruments and Automation.**

Start with the November issue; write today to:

THE INSTRUMENTS PUBL. CO., INC.
845 Ridge Avenue Pittsburgh 12, Pa.

Bulletin ! !

From the ranks of I&A subscribers, **over 2,000** requests for **advance** registration forms have been received by the managers of the First International Automation Exposition.

These are **our** subscribers—**your** customers; the engineers and executives who specify, buy, and **use your** devices for measurement and automatic control throughout industry!

Fine quality Gears can now be STAMPED by Winzeler, with a degree of *uniform* accuracy you never thought possible! That's why they are used so successfully in many unusual applications. Extremely skillful tooling, stamping and assembling by staking, brazing or riveting performed with speed and low cost efficiency in production runs only! Stock and custom dies. Ask our capable engineers for ideas and cost estimates.

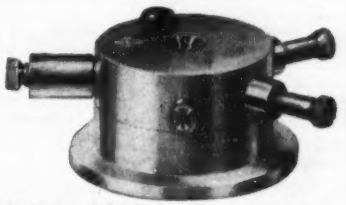
SEND FOR ***4-page folder containing valuable Stamped Gear data and tables. Write today!***

WINZELER *Stamped Gears*

WINZELER MANUFACTURING & TOOL CO.
1712 WEST ARCADE PLACE, CHICAGO 12, ILLINOIS

For more information circle **78** on inquiry card.

FOR MEASURING RADIOACTIVE EMISSION



8.3 x 6.5 x 3.5 cm. Weight 0.17 kg.

LINDEMANN-RYERSON ELECTROMETER

Was first used for photo-electric measurements. Is now used in conjunction with ionization chambers for the determination of radioactive emission. Compact, sturdy, high sensitivity, stable zero and requires no leveling. Capacitance is about 3 cm. Includes improvements developed by the Ryerson Laboratory.

OTHER CAMBRIDGE INSTRUMENTS

GAMMA-RAY POCKET DOSIMETER
is a personnel monitoring instrument to measure cumulative exposure to gamma or x-rays over a given period. Contains an ionization chamber; a quartz fibre electrometer and viewing system.

"CHANG AND ENG" FAST NEUTRON DETECTOR
follows closely original design of U. S. Atomic Energy Commission. Consists of twin ionization chambers, Lindemann Electrometer, reading microscope and dry cells. Self-contained.

PRECISION IONIZATION METER (Failla Design)
A complete instrument for null methods of radioactivity measurement where background radiation effects must be eliminated.

Send for complete information

CAMBRIDGE INSTRUMENT CO., INC.
3742 Grand Central Terminal, New York 17, N. Y.
PIONEER MANUFACTURERS OF PRECISION INSTRUMENTS

For more information circle **79** on inquiry card.

electronic frequency changers

250VA and 1000VA capacity

60~ to 60~ or 60~ to 400~

accuracy to ±0.01%

- *accurate control of frequency*
- *accurate control of voltage*
- *good wave shape*
- *portable*
- *no special wiring or installation*

SPECIFICATIONS

Model	FCD250	FCD1000	FC1000
Input voltage	95-130VAC, 1ø, 50-60~	208 or 230VAC, 1ø, 50-60~	208 or 230VAC 1ø, 50-60~
Output voltage	115VAC, 1ø, adjustable between 110-120 volts		
Output frequency	400~, adjustable ±10%	400~, adjustable ±10%	60~, adjustable between 45 and 65
Output voltage regulation	±1.0%	±1.0%	±1.0%
Output frequency regulation	±1.0% in standard models; ±0.01% with auxiliary frequency standard (output frequency is fixed when using frequency standard)		
Capacity	250VA	1000VA	1000VA
Load range	0.1 to full load		
Distortion	5% maximum		
P. F. range	Down to 0.7 F		
Time constant	0.25 seconds		
Envelope modulation	2% maximum		

These industrial and laboratory frequency changers resulted from contracts for precision inverters. They should prove useful for testing components or complete instruments that must operate over variable frequency conditions. They can also be used as sources for precision 60~ or 400~ for timing applications, or used with servo and/or gyro motors in design work.

Sorensen electronic frequency changers are also being used with field equipment such as geophysical vans, where motor generator set frequency control is often inadequate. Another use will be for checking equipment designed for 50~ (foreign) usage; conversely, the same instrument can be used to convert 50~ line to 60~ source.

Electronic frequency changers of other ratings are now in design. We shall be happy to send further information, or to correspond with you concerning your individual requirements. Address Sorensen & Co., Inc., 375 Fairfield Avenue, Stamford, Conn. In Europe, write directly to Sorensen A.G., Gartenstrasse 26, Zurich 2, Switzerland.

SORENSEN

375 FAIRFIELD AVENUE, STAMFORD, CONN.

For more information circle **80** on inquiry card.

NEW INSTRUMENTS

under MIL-R-93A. Series will be subminiature, as well as larger types which will be mounted on printed wiring (complete assembly later encapsulated into a single mass). Simplification in design is featured in both subminiature and larger models. —*Cinema Engineering Co., Division Aerovox, Burbank, Calif.*

For more information circle **359** on inquiry card.

Encapsulated Toroids

New line of encapsulated toroids features relief of mounting strains to permit physical and electrical uniformity of product; guaranteed accuracies of 0.1 percent or one turn of winding where required; hermetic sealing (MIL-T-27). Available wound on standard or temperature-stabilized cores of 125, 60, 26 or 14 permeability and with threaded or oversize hole mounting. Also coils tapped to customer's specs.—*Dietz Design and Mfg. Co., Grandview, Missouri.*

For more information circle **360** on inquiry card.

Shielded Input Transformer

New "Type O-16" is addition to "Ouncer" series; is designed to operate from a low-impedance microphone or line to grid; provides 200:1 step-up impedance ratio. Frequency response is within 1 db from 30 to 20,000 cps.—*United Transformer Co.*, 150 *Varick St., New York 13, N. Y.*

For more information circle **361** on inquiry card.

Carbon-pile Rheostats

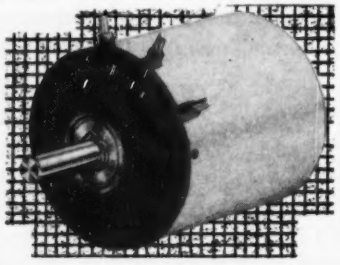
New improved carbon pile rheostats, considerably more compact than conventional units, are built of rectangular carbon plates formed in a single

pile and housed in an insulated one-piece steel box; are rated from 25 to 250 amps. on continuous service, with (higher ratings on intermittent loads). Resistance-change range as high as 50 to 1. Units operate at lower temperatures than multiple-tube or standard types.—*Hanson-Van Winkle-Manning Co., Matawan, N. J.*

For more information circle **362** on inquiry card.

Ten-turn VDRs

New "Type M10T Ten-turn Servo Potentiometers" feature a unique method of servo correction to control winding of resistor elements. Values



from 1000 to 10,000 ohms; power dissipation 5 watts at 40 C. derated to zero at 80 C. Max. starting torque 1.3 oz.-in. at 20 C.; weight 5 oz.—*Technology Instrument Corp., Acton, Mass.*

For more information circle **363** on inquiry card.

ELECTROMECHANICAL COMPONENTS

Servo-system Components

New servomotors, synchros, etc., are ¾ in. diam. but provide performance said to be "equal to or better than similar units twice as large." Feature: straight-through bore and integral stator-housing construction. Small unit in photo is servomotor with no-load speed of 6500 rpm. and stall torque of 0.1 oz.-in.; weight 1.2 oz. Synchro transmitters, control transformers and differentials with max. error limits of 10 min. from electrical zero, for use in conjunction with new motors, are 1.658 in. long and weigh 1.75 oz.—*Kearfott Co., Inc.*, 1378 *Main Avenue, Clifton, N. J.*

For more information circle **364** on inquiry card.

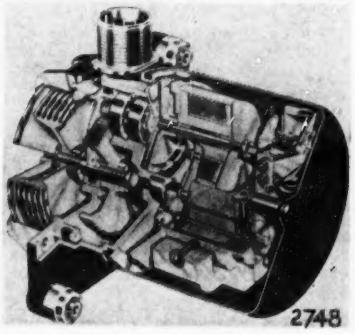
Frequency Differential

New "Size 15 Frequency Differential Type FC-15-A-1" features two separate non-connected 2-phase stators and two interconnected 3-phase rotors. When primary stator is excited in quadrature, output of secondary stator is the excitation frequency plus shaft speed. Reversing shaft direction of rotation causes output to be excitation frequency less shaft speed. Designed for primary excitation of 10 volts, 1,000 to 5,000 cps. and for operation directly from vacuum tubes. Maximum shaft speed 200 rps.—*Clifton Precision Products Co., Inc., Marple at Broadway, Clifton Heights, Penna.*

For more information circle **365** on inquiry card.

Servo Actuator

New "Model 205" position servo actuator features torque-to-inertia ratio of 200,000 rad/sec^2 coupled with an acceleration time constant of 10 milliseconds. Output capstan of instrument is free to rotate 360 deg. Drive motor features "the ideal principle of rotating only electrical conductors in a magnetic field," so that electrical inductance and stored angular momentum are extremely low. Maximum



you can banish fear of component failure

Specify AEMCO RELAYS

... BE ASSURED OF DEPENDABLE QUALITY!

The components you purchase lose their identity once they are incorporated in a manufactured unit. To the ultimate consumer, they become *your* product. The failure of the smallest component can, and often does, determine the acceptance for and the success of your unit! That's why AEMCO Relays are built to exceed 'specs' . . . *military or industrial.*

AEMCO Relays are available in a wide variety of spring and coil combinations, operating potentials and contact ratings . . . open, can type, plug-in base, hermetically sealed units . . . midgets, dual purpose, delayed make or break, circuit control, current and potential relays.

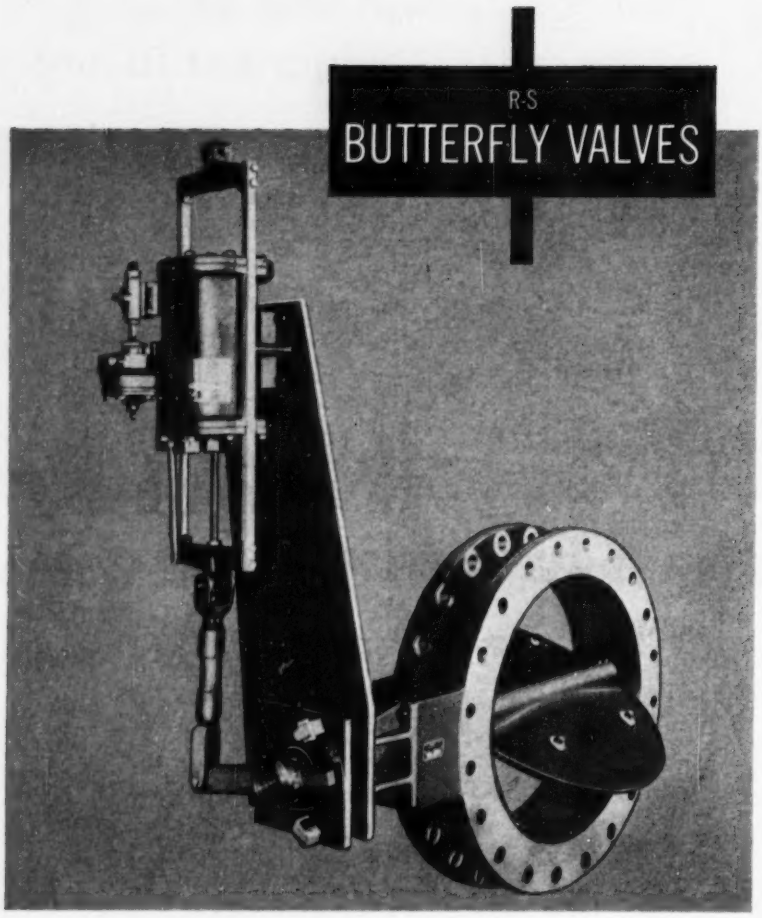
Chances are that we are supplying relays to one of your competitors . . . one of the hundreds of AEMCO stock models or one built to meet special needs and mounting requirements. We would like to help underwrite the success of your equipment by furnishing dependable AEMCO Relays *to exceed your most exacting requirements!*

The Services of our Engineering Department are Available on Request. WRITE TODAY!

AEMCO Automatic Electric MFG. CO.

58 STATE STREET · MANKATO, MINN.

For more information circle **81** on inquiry card.



R-S VALVES FOR SENSITIVE CONTROL

These design features have won complete process control acceptance for R-S Butterfly Valves. Whether in chemical, refining, paper or power systems, an R-S Valve gives you every advantage in . . .

. . . complete control in all positions of normal regulating range
. . . fast regulation and fast control
. . . minimal pressure drop
. . . compactness and lightness at less cost

R-S valves with automatic controls assure the most positive and dependable performance obtainable.

S. Morgan Smith offers you better valve engineering for your control applications. Over 75 years experience in designing and engineering for the hydraulics field are at your disposal. To find the proper valve for any application problem, or to get more information on our complete line of butterfly, cone and ball valves, write to S. Morgan Smith Company, York, Pennsylvania.

Hydraulic Turbines
Pumps
Gates & Hoists
Trash Rakes
Accessories
HYDRODYNAMICS
Rotovalves
Ball Valves
Butterfly Valves
Free-Discharge Valves
Controllable-Pitch Ship Propellers

S. MORGAN SMITH CO.

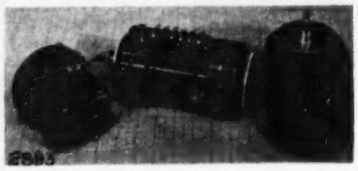
For more information circle **82** on inquiry card.

continuous torque at 28 v., 200 lb.-in.; equivalent motor stall torque 1200 lb.-in.; operating voltage 5 to 35; operating current 0.4 amp. with no load and an additional 0.1 amp. per lb.-in. of load.—*Summers Gyroscope Co.*, 2328 *Broadway, Santa Monica, Calif.*

For more information circle **366** on inquiry card.

Magnetic Clutches, Brakes

New line of miniature magnetic clutching and braking devices for application in computers, etc., includes (left to right) single clutch, double



clutch, and clutch brake. Features: continuous operation; immediate release upon de-energizing; extremely rapid pull-in; negligible steady-state control current requirement; wide environmental range; definite neutral position for the friction disk precluding dragging on friction face regardless of mounting position.—*Ford Instrument Co.*, 31-10 *Thomson Ave., Long Island City* 1, *N. Y.*

For more information circle **367** on inquiry card.

Cable-driven Mag-clutch

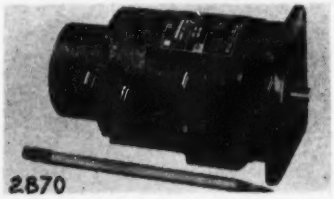
New cable drive system is added to maker's present line of magnetic clutches which have featured gear

drive. It allows greater flexibility in hand-drive positioning, as well as being a low-cost anti-backlash servo drive (typical system shown). Magnetic friction clutches used can be supplied to operate at a fixed voltage in range of 6 to 30 v.dc.—*Electronic Mfg. Engineers Co.*, 2410 *Beacon St., Seattle* 44, *Wash'n.*

For more information circle **368** on inquiry card.

Miniature A-c. M-g. Sets

New "Type BAL" miniature a-c. motor-generator sets combine a-c. synchronous motors with a-c. permanent-magnet generator. Three principal



uses: source of odd frequency from standard frequency lines; shaft extensions for driving loads permit generator to indicate position of load; by fitting unit with a rotating hous-

ing, any phase shift from 0 to 360 deg. can be simulated in relation to another generator on same unit or to an external source.—*Electric Indicator Co., Inc., Springdale, Conn.*

For more information circle **369** on inquiry card.

Incremental Motor

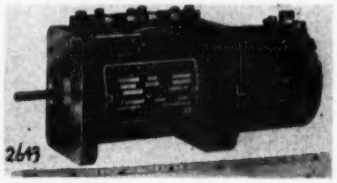
New "Model SM-300" high-speed incremental motor assures positive positioning and no loss of input signal; provides precise cw. or c-cw. rotation-

al step of external shaft load at command of one or two independent sources. (Among applications, summing digital information as shaft rotation.) Weight 8 oz. Rate: up to 12½ rectangular pulses per second from either source in any order, provided that inter-pulse spacing be 0.008 sec. or more.—*Stepper Motors Corp., P. O. Box 466, Culver City, Calif.*

For more information circle **370** on inquiry card.

Motor-generator

New "Type MG 10-712-60" combines an induction motor having a high torque-to-inertia ratio with a



linear drag cup generator. Characteristics at 60 cps: Motor: 115 v.; input, motor stalled, 26 watts total; torque (stalled) 6.7 oz.-in. Generator: 115 v.; phase 2 voltage output 4.1 ± 0.7 v. per 1000 rpm.; phase 2 residual voltage 35 mv. maximum. Reversing time 0.04 sec. Moment of inertia 17.5 gm.cm². Weight 43 oz. Also available for operation from 400-cps. source.—*Electric Indicator Co., Inc., Springdale, Conn.*

For more information circle **371** on inquiry card.

Control-circuit Relays

New relays, said to be ideal for plate circuit use and current- and voltage-sensing applications, incorporate snap switches for on-off switching action. Where required (for example in frequency-selective circuits) on-off snap action is "so sensitive that drop-out voltage or current is 1 percent of pull-in voltage or current." Two main groups: precision types for high accuracy, identical repeatability, and resistance to shock and vibration; and those for on-off duty applications. Shown is "Type RL-516," s-p.d-t.; 6400-ohm coil; pulls in at 4 ma. and drops out at 2 ma. (with a detent re-

FOR MORE ACCURATE MEASUREMENT

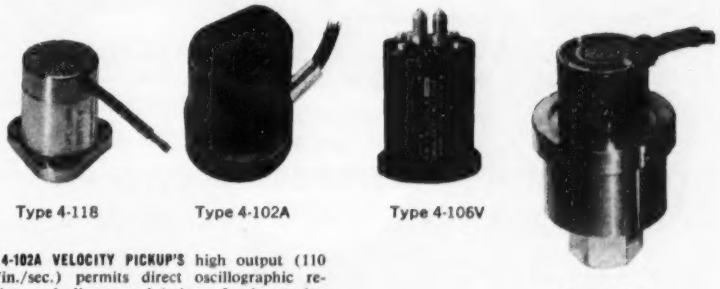
of *vibration...*

USE CEC VELOCITY PICKUPS

Vibration in all planes and under all conditions can be measured accurately with the proper CEC velocity pickup. These instruments combine high output with extreme ruggedness and wide adaptability. For complete details write for Bulletin CEC 1503V-X1.

THE 4-118 MINIATURE SELF-GENERATING VELOCITY PICKUP is ultra compact and lightweight. Electromagnetically damped, its design permits operation at temperatures up to 500° F. Its output (105 mv./in./sec.) equals that of pickups many times its size and weight (1.3 oz.), and it may be operated in any plane of orientation. Frequency range is 50 to 500 cps. Common applications include gas turbines, jet engines, superchargers and automobile engines.

THE 4-106V (VERTICAL VIBRATION) velocity pickup as well as the 4-106H (horizontal vibration) are identical except for sensitivity and the plane of orientation. Widely used for many years, their light weight makes them advantageous for many applications. Frequency range is 7 to 1000 cps.



Type 4-118 Type 4-102A Type 4-106V Type 9-102

THE 4-102A VELOCITY PICKUP'S high output (110 mv./in./sec.) permits direct oscillographic recording and direct modulation of telemetering sub-carrier oscillators without use of amplifiers. It will stand transverse acceleration to 35 g's, and positive sealing of damping fluid allows operation at extreme altitudes and at temperatures of from 0° to 150° F. Frequency range is 8 to 700 cps. The 4-103 is similar to the 4-102A, but is designed for ambient temperatures of 150° to 250° F. Unique, patented seismic suspension design eliminates friction, permits accurate measurement of minute amplitude in any plane of orientation.

THE 9-102 TORSIOGRAPH (TORSIONAL VELOCITY PICKUP) detects and measures transient or cyclical deviations from average rotational velocity. Collet-type mounting to shafts from 15/16" to 1-1/4" diameter. Usable from 2 to 1000 cps. This instrument is widely used for the evaluation of reciprocating engine performance.

Consolidated Engineering CORPORATION

309 North Sierra Madre Villa, Pasadena 15, California

ANALYTICAL INSTRUMENTS FOR SCIENCE AND INDUSTRY

Sales and Service through **CEC INSTRUMENTS, INC.,** *a subsidiary with offices in Pasadena, Atlanta, Chicago, Dallas, Detroit, New York, Philadelphia, Washington, D. C.*

For more information circle **83** on inquiry card.

.0001"

COORDINATE MEASUREMENTS CAN BE MADE DIRECT ON THE

Gaertner TOOLMAKER'S MICROSCOPE

Using Full 2" Precision Screws

This and the following features make the Toolmakers' Microscope an almost indispensable instrument in your shop or laboratory.

Range 2 x 4 inches
360° Stage Rotation
Reading to 1 minute

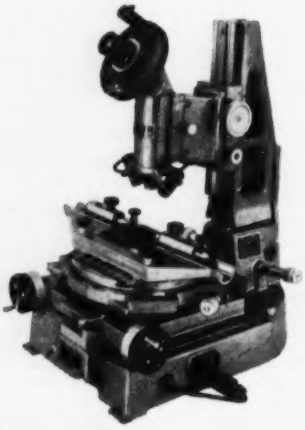
Protractor Circle
Range 360°
Reading to 1 minute

Magnification 30X

Stage Motion
By 2 inches
Precision Screws

Column Tilt 8°
For Helix Measurement

Rugged Construction
for Many Years of
Dependable Accurate Service

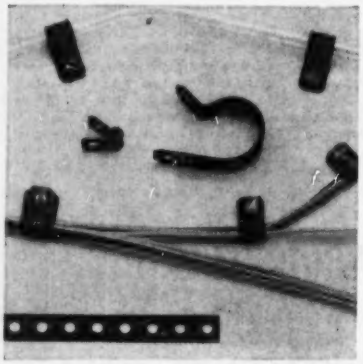


For a completely illustrated book listing detailed specifications and accessories request Bulletin 147-50.

THE GAERTNER SCIENTIFIC CORPORATION

1211 Wrightwood Avenue • Chicago 14, Illinois

For more information circle **84** on inquiry card.



Hold open wiring, fragile tubing, etc., with these **NyGrip*** plastic cable clips and perforated strapping —light weight, flexible, strong. *TM

Write for free samples, information.

WECKESSER CO., 5258 N. Avondale Ave., Chicago 30

For more information circle **85** on inquiry card.

NEW INSTRUMENTS

sistor, pulls in at 4.0 ma. and drops out at 3.95 ma.; sensitivity goes as low as 80 milliwatts.—*Joseph Pollak Corp.*, 81 *Freeport St., Boston* 22, *Mass.*

For more information circle **372** on inquiry card.

Instrumentation Relays

New "Part No. 8-4C" ("8" type followed by contact designation) relays are for computers and other instruments, plate circuits, remote controls, etc., has extremely low friction loss and power consumption. Various contact arrangements up to maximum of 4pdt, 6pdt, or 2d (make-before-break) can be obtained by combinations of basic types. Ratings: 3 amps. 32 vdc. resistive or 115 vac. non-inductive. Also available hermetically sealed in miniature 9- or 14-pin plug-in, or solder terminal types.—*Leach Relay Co.*, 5915 *Avalon Blvd., Los Angeles* 3, *Calif.*

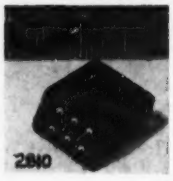
For more information circle **373** on inquiry card.

Heavy-duty Relays

New "Part Nos. 9094 and 9194" handle heavy contact loads (½ hp.) with low coil power requirements (4.4 watts). Insulation, spacing and contact life exceed (UL) requirements for industrial control equipment. Coils are vacuum varnish impregnated. Weight 7.5 oz.; length 3 in., width 1 7/8 in., height 1 15/16 in.—*Leach Relay Co.* 5915 *Avalon Blvd., Los Angeles* 3, *Calif.*

For more information circle **374** on inquiry card.

Subminiature Relay



New "P-100" subminiature relay, claimed to be "the most sensitive now in production," also offers thermal and shock stability and fast (0.005-sec.) reaction time; is manufactured by ECC (Telecommander) Ltd. of England; is of polarized type and has a resistance of 3500 ohms; can be adjusted to make contact at 1 ma. and to break at 0.8 ma.; can be operated at rates up to 90 per second. Contacts handle up to 0.25 amps at 250 volts.—*American Telasco Ltd., Huntington, N. Y.*

For more information circle **375** on inquiry card.

Telephone-type Relay

New hermetically-sealed telephone-type relay is 1-5/8 in. wide, 1-7/16 in. long and 2 in. high (classified as a midget type); weight 6 oz.; high shock and vibration resistance makes it applicable to aircraft, etc.; meets MIL-R-5757 or MIL-R-6106. Standard-contact model 2 amps, 115 v. 60 cps. or 28 v.dc. non-inductive; with silver contacts 5 amps. Maximum switching combination 4-p.d-t.—*Sealectric Switch and Relay Div., Williams Mfg. Co.*, 4242 *Fillmore St., Chicago* 24, *Ill.*

For more information circle **376** on inquiry card.

Sensitive Relay

New sensitive relay is designed primarily for use in chassis which have sufficient height but little adjacent space. It provides a hermetically-sealed d-p.d-t combination, capacity up to 3 amp. inductive load. Coil resistances up to 30,000 ohms. D-c. relays with drop-out approx. 80 percent of pick-up are in production; a-c. units soon.—*Hedin Tele-Technical Corp., 640 W. Mt. Pleasant Ave., Livingston, N. J.*

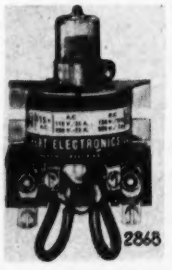
For more inforamtion circle **377** on inquiry card.

Sealed Aircraft Relay

New "Part No. DC-36" 26.5-v.dc. relay is filled with inert gas; exceeds electrical and mechanical requirements of USAF MIL-R-5757. Contacts 6-p.d-t. (break-before-make) pure silver, 2 amps. @26.5 vdc. resistive load; input sensitivity 72 milliwatts. Weight 4 oz.—*Deltronic Corp., 9010 Bellanca Ave., Los Angeles 45, Calif.*

For more information circle **378** on inquiry card.

Mercury-plunger Relay



New mercury plunger relay embodies several improvements. Mercury cup (mercury-to-mercury operation) is now made of virtually indestructible "Alumina"; design of the Bakelite blocks has been changed for greater ease of installation; label has been completely redesigned to show all Tube Load Ratings for inductive and non-inductive loads at a glance.—*Ebert Electronics Corp., 212-26 Jamaica Avenue, Queens Village 28, L. I., N. Y.*

For more information circle **379** on inquiry card.

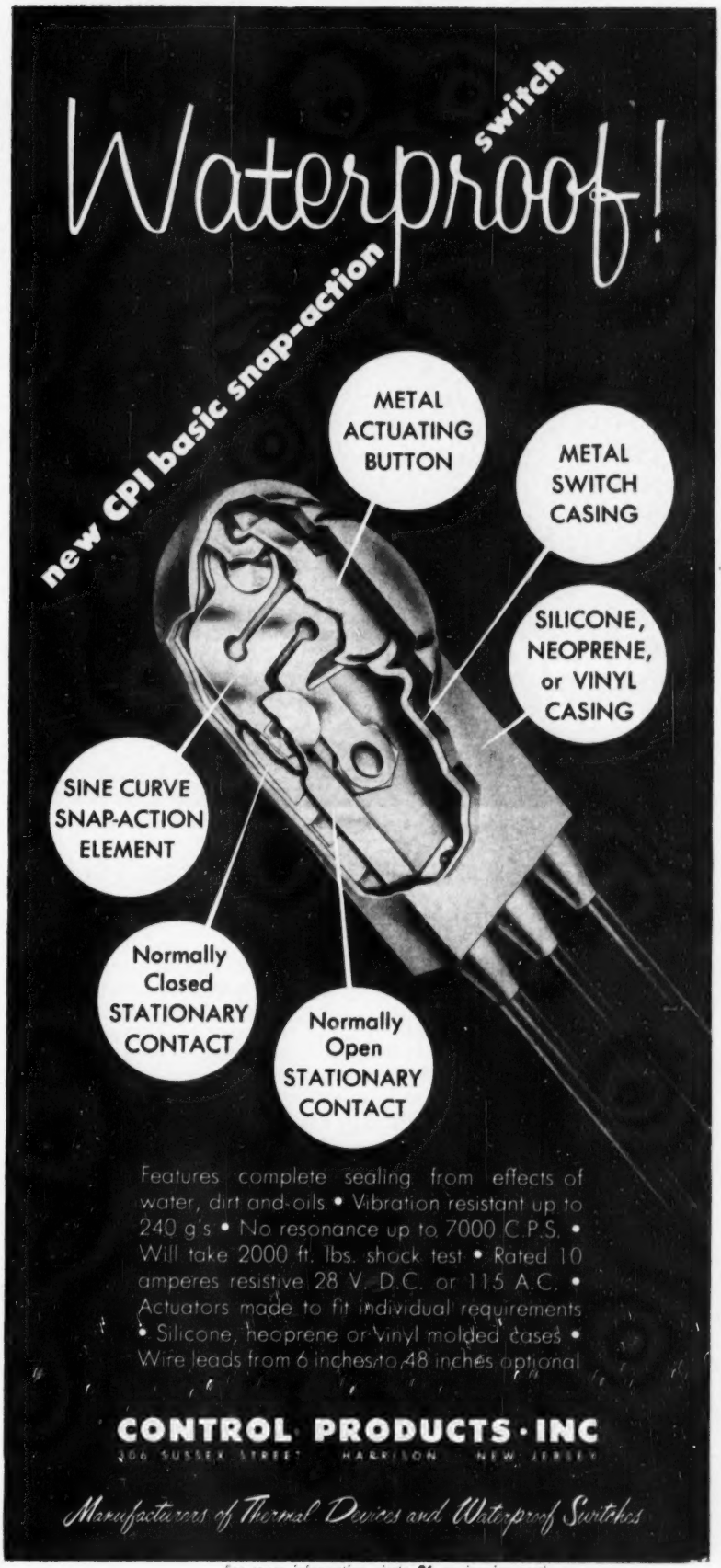
Miniature Chopper

New "A-175," said to be "the smallest 60-cycle chopper in existence," is break-before-make, s-p.d-t.; handles signal levels from 100 v. down to microvolt region at 1 ma.; withstands 30-*G* vibration; can be operated at any ambient from –65 C. to 100 C. or at any frequency from 30 to 150 cps. At 6.3 v., 60-cps., phase angle is 20 deg. and dwell time 167 deg. Noise level is extremely low. Service life exceeds 1000 hours.—*The Airpax Products Co., Middle River, Baltimore 20, Md.*

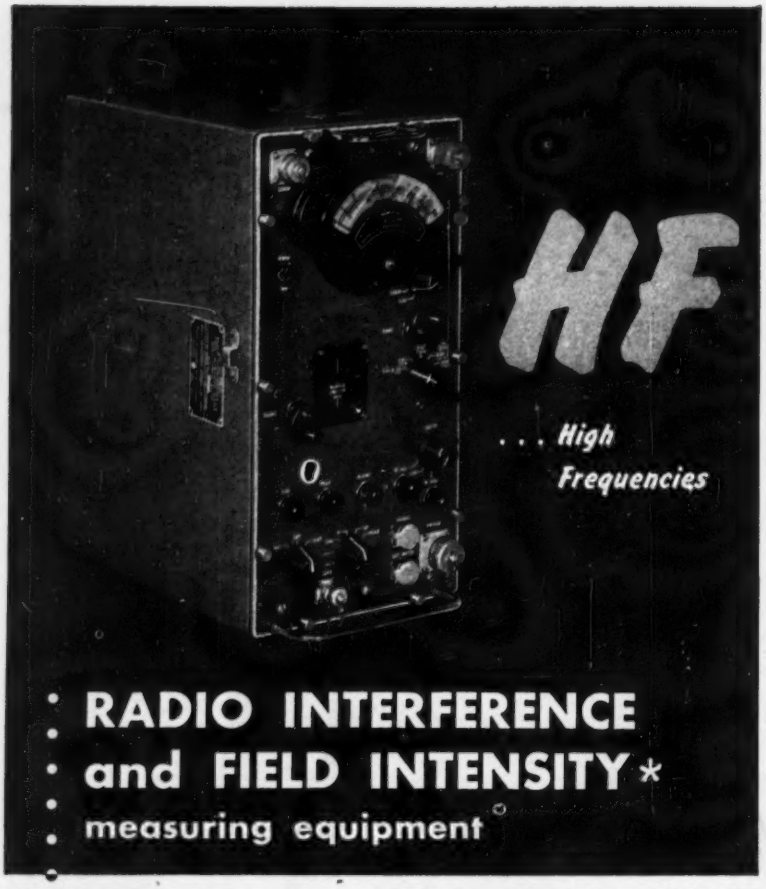
For more information circle **380** on inquiry card.

Holding-coil Switch

New "Series A 1200" holding coil switch performs the functions of a relay plus two conventional switches; has a built-in solenoid which holds


Waterproof! switch
new CPI basic snap-action
METAL ACTUATING BUTTON
METAL SWITCH CASING
SILICONE, NEOPRENE, or VINYL CASING
SINE CURVE SNAP-ACTION ELEMENT
Normally Closed STATIONARY CONTACT
Normally Open STATIONARY CONTACT
Features complete sealing from effects of water, dirt and oils • Vibration resistant up to 240 g's • No resonance up to 7000 C.P.S. • Will take 2000 ft. lbs. shock test • Rated 10 amperes resistive 28 V. D.C. or 115 A.C. • Actuators made to fit individual requirements • Silicone, neoprene or vinyl molded cases • Wire leads from 6 inches to 48 inches optional
CONTROL PRODUCTS · INC
306 SUSSEX STREET HARRISON NEW JERSEY
Manufacturers of Thermal Devices and Waterproof Switches

For more information circle **86** on inquiry card.



RADIO INTERFERENCE
and FIELD INTENSITY*
measuring equipment

Stoddart NM-20B • 150kc to 25mc

Commercial Equivalent of AN/PRM-1A

WIDE FREQUENCY RANGE . . . Covering the most widely used portion of the radio-frequency spectrum, the NM-20B is a precision instrument designed for field or laboratory measurement, analysis and interpretation of all types of radiated and conducted radio-frequency signals and interference. Sturdy dependability, broad frequency range and a full complement of accessories fit this instrument's outstanding characteristics to an impressive variety of applications. Includes standard broadcast band, radio range, WWV, ship-to-shore, amateur and other communication frequencies.

SELF-CONTAINED BATTERIES . . . Battery power allows portable operation of the NM-20B. The ac power supply permits operation from 105 to 125 volts or 210 to 250 volts ac at any frequency between 50 cps and 1600 cps. Its versatile power requirements and special weather-proof construction provide unlimited field operation.

PICKUP DEVICES . . . Pickup devices available for use with the NM-20B include the loop and loop probe, rod antennas and matching impedances for conductive inputs. These permit unlimited usefulness in measuring both conducted and radiated interference.

Stoddart RI-FI* Meters cover the frequency range 14kc to 1000mc

VLF
NM-10A, 14kc to 250kc
Commercial Equivalent of AN/URM-65. Very low frequencies.

VHF
NM-30A, 20mc to 400mc
Commercial Equivalent of AN/URM-47. Frequency range includes FM and TV bands.

UHF
NM-50A, 375mc to 1000mc
Commercial Equivalent of AN/URM-17. Frequency range includes Citizens band and UHF color TV band.

STODDART AIRCRAFT RADIO Co., Inc.
6644-D Santa Monica Blvd., Hollywood 38, California • Hollywood 4-9294

For more information circle **87** on inquiry card.

NEW INSTRUMENTS

switch on contact until solenoid coil circuit is externally interrupted. This circuit, as well as external s-p.s-t. switch circuit, may also be broken manually by pulling switch knob. New switch also eliminates wiring needed to interconnect relay, switches, and pilot light commonly used in holding-coil circuits.—*Hetherington, Inc., Sharon Hill, Penna.*

For more information circle **381** on inquiry card.

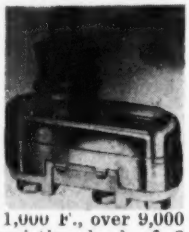
Miniature Rotary Switches

New "Eldec Sub-miniature Rotary Switch" for low-current applications is 0.908 in. long; weighs less than

¼ oz. including knob. Available in 1-, 2-, and 3-pole, (15 terminals per switch) also in 2-, 3-, and 4-gang.—*Electro Development Co., 6006 W. Washington Blvd., Culver City, Calif.*

For more information circle **382** on inquiry card.

High-temperature Switch

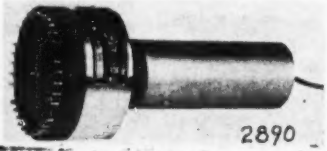


New "IHTI" is said to be ideal for high-temperature aircraft and industrial applications. Tests at 700 F. show life in excess of 25,000 operations at a resistive load of 5 amps. 28 v.dc.; at 1,000 F., over 9,000 operations with resistive load of 2 amps. 28 v.dc.—*Micro Switch, Freeport, Ill.*

For more information circle **383** on inquiry card.

Sampling Switch

New "4000 Series Roto-Speed" multichannel unit is said to embody unique wiper design and selected contact material; is d.c. motor driven at any



standard voltage; samples up to about 100,000 contacts per minute. Unit shown has 60 contacts with alternate contacts brought to terminals. Available with subminiature connectors in place of terminals. ★ "6000 Series" is similar but without motor drive.—*General Devices, Inc., P. O. Box 253, Princeton, N. J.*

For more information circle **384** on inquiry card.

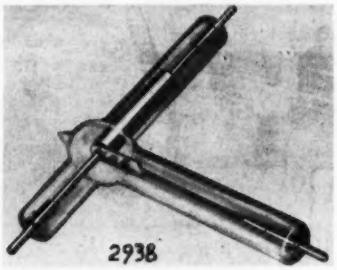
Multi-station Switches

New "Series 5700 and 5900" multiple-station interlocking push button switches are available in capacities of 4 to 12 stations. Each station may be equipped with various combinations of contact assemblies. All stations are interlocked: pressing any button releases any other previously-operated button (several options available).—*Donald P. Mossman, Inc., Brewster, N. Y.*

For more information circle **385** on inquiry card.

High-voltage Switch

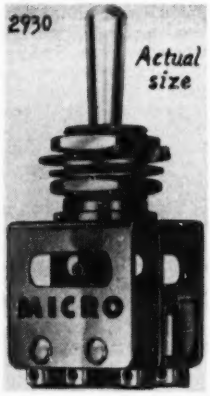
New "Part NVS-300" vacuum switch is externally operated by a d-c. solenoid; is n-c. s-p.d-t. For pulse application, switching is done under no-



load conditions; breakdown test voltage between open contacts shall be 20 kv.dc. Typical pulse operation: pulse duration 2.4 usec., pulse repetition 420/sec.; peak current 300 amps. Typical d-c. conditions: 1.5 amp. at 5 kv. may be switched under load in non-inductive circuits. Vibration: 10 *G.—N.A.E.R. Corp.*, 2301 *So. Purdue Ave., West Los Angeles* 64, *Calif.*

For more information circle **386** on inquiry card.

Midget Toggle Switches



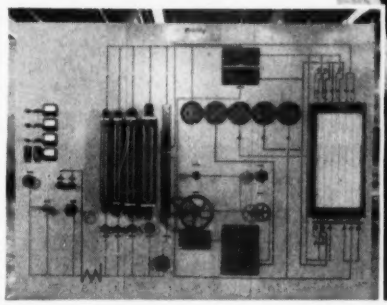
New 3-position panel-mounting small toggle switch assemblies are offered. Each unit has two s-p.d-t. basic switching units, providing control of as many as four circuits. It is possible to have three different combinations of two circuits open and two circuits closed at any time. "13AT1" is momentary on, maintained off; momentary on; "13AT2" is maintained on, maintained off, maintained on; and "13AT3" is momentary on, maintained off, maintained on.—*Micro Switch, Freeport, Illinois.*

For more information circle **387** on inquiry card.

Self-cleaning Switch

New self-cleaning switch, for use in test equipment, is a 12-position continuous-rotation low-internal-resis-

Tenney Engineering, Inc., of Union, New Jersey and Baltimore, Maryland, are leading designers and fabricators of environmental test chambers and are making this special unit for a major aviation manufacturer to study the flow of air through instruments.



7 CONDITIONS IN TENNEY CHAMBER INDICATED WITH MERIAM MANOMETER ACCURACY

● Each of seven Meriam Manometers dependably indicates a range of seven important conditions of air flow, pressure or vacuum in this special Tenney Chamber. A steel plate horizontally divides the chamber. Air under pressure is introduced into one section while the other is under partial vacuum.

The first Meriam Manometer indicates vacuum or pressure in the top section, while Manometer #2 gives the same information for the bottom. Manometer #3, also graduated in inches of mercury, indicates differential across the plate.

By turning a valve, Manometer #4 indicates feet of altitude simulated in either section. Manometer #5 and 6 are graduated in inches of water and inches of mercury respectively to show differential pressure across the orifice at the entrance to the top section. Manometer #7 gives the orifice upstream pressure in inches of mercury.

If you have a problem involving pressure or flow of liquids and gases, possibly you can solve it with a Meriam Instrument—a primary standard of indication. Call your Meriam Instrument Man or write today.

At the Instrument Show stop at the Meriam Instrument Company Booths #751, 753, and 755.

THE MERIAM INSTRUMENT CO. 10958 Madison Avenue, Cleveland 2, Ohio

Western Division: 4760 E. Olympic Blvd., Los Angeles 22, Calif.

In Canada: Peacock Bros., Ltd., Montreal

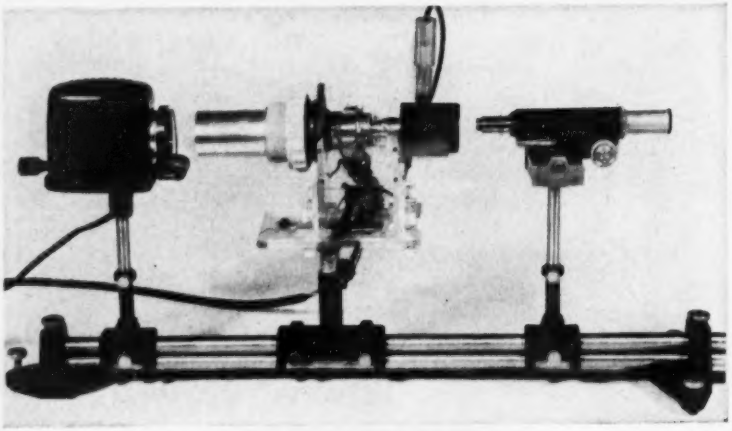
MERIAM ★ *Instruments* ★

ESTABLISHED 1911

MANOMETERS, METERS AND GAUGES FOR THE ACCURATE MEASUREMENT OF PRESSURES, VACUUMS AND FLOWS OF LIQUIDS AND GASES

For more information circle **88** on inquiry card.

A NEW APPROACH TO THE PROBLEMS OF INSTRUMENTATION



THE Meyer

UNIVERSAL INSTRUMENT BENCH

THE PROBLEM → TO PROVE OUT AND TEST INSTRUMENT SYSTEMS IN OPTICS, ELECTRONICS, PHYSICS, PHOTOGRAPHY, ELECTRO-MECHANICS, AND ALLIED FIELDS.

THE APPROACH → BY THE USE OF OVER 50 COMPONENTS WHICH CAN BE ASSEMBLED IN THOUSANDS OF COMBINATIONS. WITH ANY NUMBER OF THESE COMPONENTS A TREMENDOUS RANGE OF INSTRUMENTATION SETUPS CAN BE MADE IN A MATTER OF MINUTES.

THE SOLUTION → THE ILLUSTRATION SHOWS A SET-UP FOR TESTING THE IMAGE QUALITY OF AN ELECTRON TUBE OR THE OPTICAL PROPERTIES OF A LENS.

AREAS OF APPLICATION → FOR RESEARCH AND DEVELOPMENT ON THE PRODUCTION LINE IN ASSEMBLY AND INSPECTION INDUSTRIAL PHOTOGRAPHY

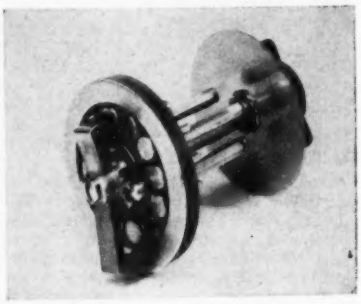
For a complete 20 page descriptive catalogue send to

Meyer-Opticraft, Inc.

(Formerly Hugo Meyer & Co.)

39 West 60th St. New York 23, N. Y.

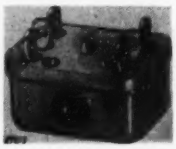
For more information circle **89** on inquiry card.



tance detent-action type with phosphor-bronze wiper contacts.—*Industrial Instruments, Inc., 89 Commerce Road, Cedar Grove, N. J.*

For more information circle **388** on inquiry card.

Aircraft Snap Switch



New "8102" positive double-action switch is said to be "the smallest hermetically-sealed snap-action-blade d-p. d-t. switch on the market today"; resists dust, ice, humidity, oil, high and low temperature changes and fungus. High contact pressure makes it resist extreme vibration. It is said to operate with "less than half the effort required by standard aircraft quality switches." Resistive rating (0 to 50,000 ft.) 25 amps at 28 v.dc. or 100 v.ac.—*Haydon Switch Co., 232 N. Elm St., Waterbury 20, Conn.*

For more information circle **389** on inquiry card.

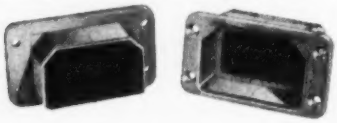
Circuit-card Connectors

New "KKM Series" connectors for plug-in printed circuit card applications are available in sizes from 6 to 22 contact positions; employ a unique contact design that permits simplification of production methods, whence minimal manufacturing costs. Spring-temper phosphor-bronze contacts assure positive wiping action, are offered in either of two terminal styles: (1) slotted eyelet for soldering up to three #20 AWG cable wires per contact or (2) plain terminal to permit wrapping cable wire by using Western Electric "Wire-Wrap" tool. Voltage breakdown between contacts at sea level 3800 v.dc., at 60,000-ft. altitude 1200 v.dc.—*Winchester Electronics, Inc., Dep't R, Glenbrook, Conn.*

For more information circle **390** on inquiry card.

Rack-&-panel Connectors

New "DPA" and "DPX" connector series in comparatively miniature sizes occupy approx. 35 percent less area for rack, panel or chassis mounting than the maker's standard "DPD" series. Contact arrangements currently available include standard 5- and 10-amp. and coaxials (5-amp.) up to

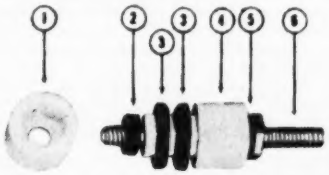


32 contacts, with two "DPA" and seven "DPX" layouts available. Insulation: melamine or "Diall 51-01." Shell is lightweight aluminum alloy.—*Cannon Electric Co., 3209 Humboldt St., Los Angeles 31, Calif.*

For more information circle **391** on inquiry card.

Seal Bushings

New "Heldor HLI-5000" non-turning hermetic seal bushing meets MIL-

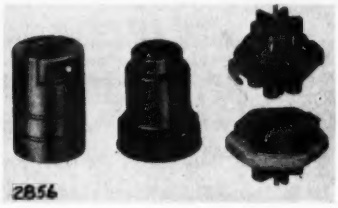


T-27 specs and twist test.—*Heldor Mfg. Corp. 238 Lewis St., Paterson, N. J.*

For more information circle **392** on inquiry card.

Six-contact Connector

New "FHL Continental" 6-contact connector has 4000-v. sea-level breakdown and 5-amp. current rating. High

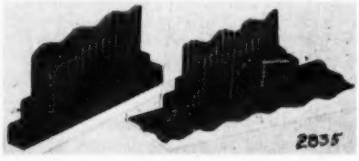


voltage capacity is made possible by deep "wells" which surround individual contacts and prevent arcing.—*Electronic Sales Div., DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.*

For more information circle **393** on inquiry card.

Graphic-circuit Connectors

New "Series 3370 and 3371" card receptacles are said to offer many unique and exclusive features



that improve engineering application to printed circuitry." Enclosed contact tips and positive pressure-type contacts assure self-assembly and foolproof service in operation. Number of contacts can be up to fifteen.—*H. H. Buggie, Inc., 726 Stanton St., Toledo 4, Ohio.*

For more information circle **394** on inquiry card.

Graphic-circuit Receptacle

New printed circuit receptacle provides 20 contacts in space formerly containing only 18. In addition, contacts are said to result in more positive connection and longer life. They are made of beryllium copper wire, and are formed—not stamped or machined—then heat-treated to give ex-

You can have DRY AIR with exact moisture control

ASSEMBLING ELECTRONIC PARTS

FOR YOUR COMFORT
FOR YOUR PROCESS
FOR TESTING MACHINES OR MATERIALS AT ANY TIME OF THE YEAR

PACKAGING FOOD PRODUCTS

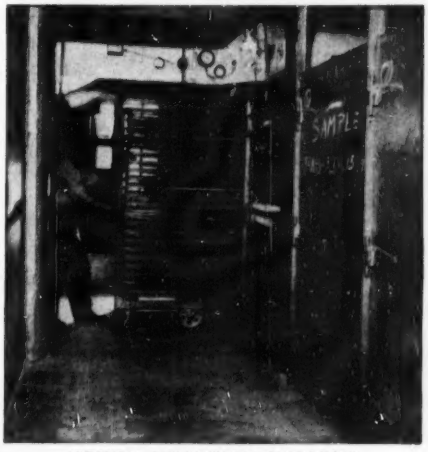
● This Niagara "Controlled Humidity" method gives you the **MOST EFFECTIVE** Air Conditioning because its cooling and heating functions are made completely separate from adding or taking away moisture. This assures you always a precise result. No moisture sensitive instruments are needed.

MOST FLEXIBLE. You can reach and hold any condition in response to instrument settings, or vary it as you wish.

EASIEST TO TAKE CARE OF. The machine is accessible, the control circuits are simple and easy to operate, and there are no solids, salts or solutions to be handled.

MOST COMPACT. It does a very large amount of work in a small space.

INEXPENSIVE TO OPERATE. At normal atmospheric temperatures (unlike systems that use refrigeration to dehumidify) it needs no summer re-heat.



DRYING INDUSTRIAL MATERIAL

Write for Bulletins 112 and 122

NIAGARA BLOWER COMPANY

DEPT. IN, 405 LEXINGTON AVE. NEW YORK 17, N. Y.

Niagara District Engineers in Principal Cities of U. S. and Canada

For more information circle **90** on inquiry card.

PRECISION ANALOG COMPUTERS... rapidly and accurately solve complex engineering problems!

Time Saving • Money Saving

Electronic Associates Computation Center near Princeton, N. J.

At the EA Computation Center you may solve complex problems in Applications Engineering, Simulation, and Engineering Design by renting EA Analog Computation Equipment by the hour, week, or month.

Scientists, engineers, and mathematicians experienced in the use of analog computers are available to assist in problem solution.

PRECISION ANALOG COMPUTATION EQUIPMENT IS ALSO AVAILABLE FOR PURCHASE.

Throughout the design of this computing equipment the objective was to produce the most accurate, versatile and dependable equipment possible at a reasonable price. In achieving this end, many of the latest advances in the art have been incorporated which contribute to the superiority of this equipment.

EA Precision Analog Computer, Type 16-31R

If you state your interest, we will be glad to send you applicable data. Write to Dept. IA.

PRECISION ANALOG COMPUTING EQUIPMENT FOR SOLVING PROBLEMS IN DYNAMICS

ELECTRONIC ASSOCIATES

LONG BRANCH • NEW JERSEY

For more information circle **91** on inquiry card.

ENGRAVE

NAME PLATES • PANELS • DIALS

in your own shop

Lowest set-up time for unskilled labor

CALIBRATIONS | PROFILES | CURVED SURFACES

10,000 in use. The speediest, most versatile portable engraver. Only the NEW HERMES has these features:

• Adjustable for 15 ratios. • Self-centering holding vise. • Automatic depth regulator. • Adjustable copy holders.

Send direct to us for booklet IM 37

NEW HERMES ENGRAVING MACHINE CORP.
13-19 University Place, New York 3, N. Y.

For more information circle **92** on inquiry card.

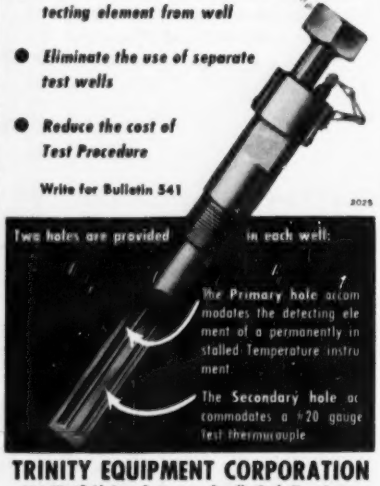
TRINITY

DOUBLE-BORE THERMOWELLS

- *Minimize the factors of error in Temperature Instrument Test Procedures*
- *Permit accurate test without removing detecting element from well*
- *Eliminate the use of separate test wells*
- *Reduce the cost of Test Procedure*

Write for Bulletin 541

2025

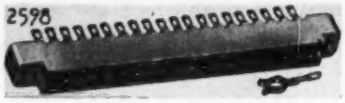

Two holes are provided in each well:
The Primary hole accommodates the detecting element of a permanently installed Temperature instrument
The Secondary hole accommodates a #20 gauge Test thermocouple

TRINITY EQUIPMENT CORPORATION
494 Westfield Ave., East • Roselle Park, New Jersey

MANUFACTURERS OF THERMOWELLS, VENTURI FLOW INDICATORS AND OTHER PROCESS EQUIPMENT

For more information circle **93** on inquiry card.

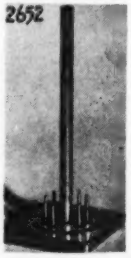
NEW INSTRUMENTS



tra spring-action. They are gold-plated over silver for maximum conductivity, soldering ease, and corrosion-resistance. Connectors have 20 contacts, including one dummy contact for positive polarization. Contacts are supplied with pierced tabs (as shown) or unpierced.—*Viking Electric*, 1061 *Ingraham St., Los Angeles* 17, *Calif.*

For more information circle **395** on inquiry card.

Feed-through Terminals

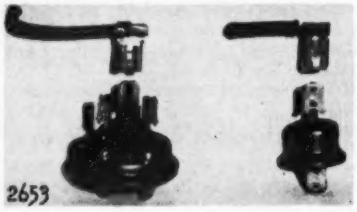


New hermetically-sealed electrical feed-through terminals feature a new exhaust tube for evacuation of atmospheres. Tube is ⅛-in. I.D.; can be placed in any multiple cluster of terminals; is spun into center of cluster for a tight mechanical lock and then solder-sealed. Mechanical joint prevents tube from falling out during subsequent soldering operations.—*Fusite Corp.*, 6000 *Fernview Ave., Cincinnati* 13, *Ohio.*

For more information circle **396** on inquiry card.

Feed-through Terminals

New hermetically-sealed feed-through terminals can be used in higher horsepower ratings; are pri-

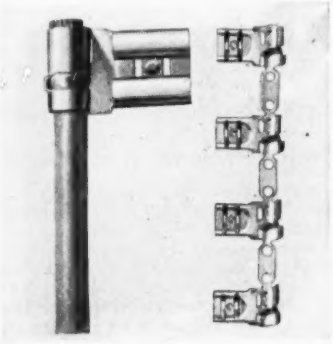


marily designed for high production in refrigeration industry.—*Fusite Corp.*, 6000 *Fernview Ave., Cincinnati* 13, *Ohio.*

For more information circle **397** on inquiry card.

Solderless Terminals

New "Flag" style has been added to maker's standard line of "Faston" connectors; is said to be "the only



successful right angle fast connecting terminal to be completely solderless for wire sizes #18 through #12 AWG"; will accommodate insulations normally used in automotive and appliance wiring in those sizes.—*Aircraft Marine Products*, 2100 *Paxton St., Harrisburg, Pa.*

For more information circle **398** on inquiry card.

MECHANICAL COMPONENTS

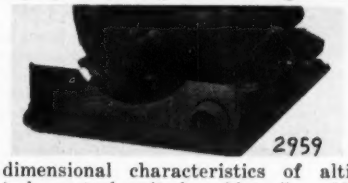
Cams and Followers

New precision cams are offered in various types and sizes for "practically any kind of application": as compact mechanical memories for analog computers, etc.; can be manufactured as "packaged units," complete with followers and all necessary gearing, mounted and ready for incorporation into the user's system, or supplied alone. Two major groupings: Three-dimensional (3-D) cams which continuously satisfy arbitrary function $z = f(x,y)$ where x and y are independent variables and z is output. "Single-input" cams include grooved flat cams, external flat cams, and grooved cylindrical cams. Cam design service is available.—*Ford Instrument Co.*, 31-10 *Thomson Ave., Long Island City* 1, *N. Y.*

For more information circle **399** on inquiry card.

Vibration and Shock Mount

New "Model K122" is an all-metal advanced-design single-stage mounting system, designed for weight and

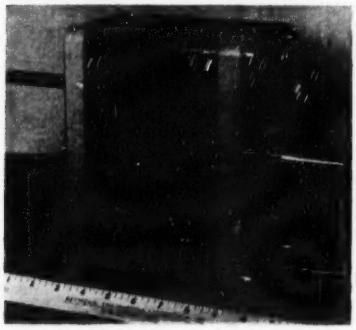


dimensional characteristics of altitude control unit, is said to "provide protection hitherto unattainable."—*Robinson Aviation, Inc., Teterboro, N. J.*

For more information circle **400** on inquiry card.

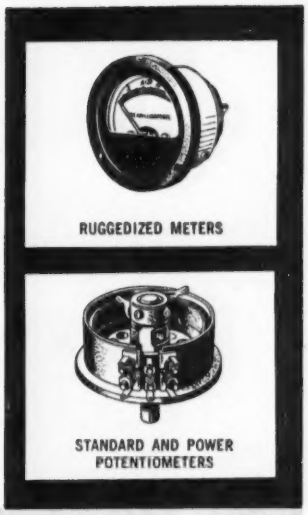
Magnetic-fluid Transmission

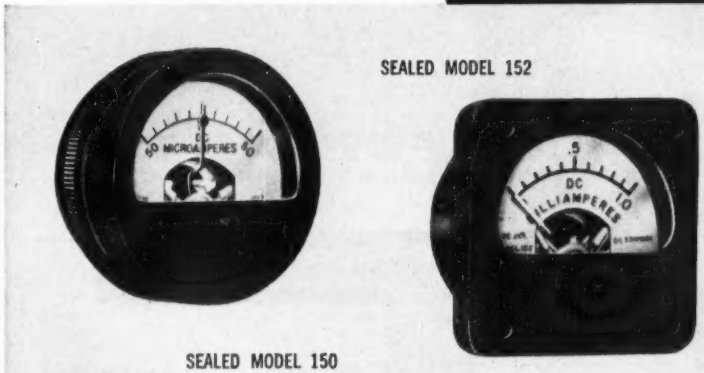
New "Model 795" is, in effect, a variable-torque selective-rotation transmission employing a pair of magnetic-fluid clutch elements located side-by-side and driven in opposite directions from input shaft and back-to-back gearing. Direction and magnitude of transmitted torque depends on which clutch is energized and amount



sealed...
ruggedized
instruments
by DeJUR

Simplify your panel meter problems



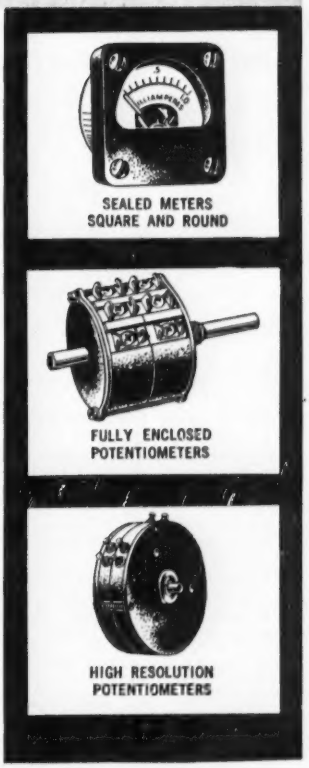


New DeJUR 1½" sealed meters

Built to MIL M-3823 specifications

Here are new, high precision panel instruments designed for use in a wide variety of environmental applications. They're sealed, waterproof and have high resistance to shock. Even damage to the scale window will not destroy the watertight seal to the panel. Featured also are the DeJUR miniaturized external pivot D'Arsonval movements for high stability and accuracy, and high flux density Alnico magnets.

These meters are also available as self-contained AC rectifier types, and with various scales and ranges to meet your prototype or production requirements. In addition, we manufacture sealed and ruggedized meters in 1", 1½", 2½", 3½" and 4½", round or square. For detailed engineering literature write Dept. IM-9, DeJUR-Amsco Corporation, 45-01 Northern Blvd., Long Island City 1, N. Y.

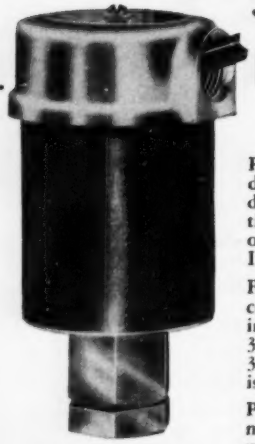


Electronic Sales Division DeJUR

45-01 NORTHERN BLVD., LONG ISLAND CITY 1, N. Y.

For more information circle **94** on inquiry card.

New! Atkomatic
SOLENOID
Stainless Steel
Direct Lift Valve
to 5000 P.S.I.



Rugged, simple, compact, heavy-duty, two way valve for broad industrial applications. Assures continuous service, nothing to wear out, has only two moving parts. Instantaneous action.

Features higher pressures, greater corrosion resistance. ⅛ and ¼ inch pipe sizes, orifices 1/16 to 3/16 inch diameter. Bodies are 303 Stainless, Solenoid armature is 416 Stainless.

Pressures: 5000 P.S.I. to 150° F. maximum, 2500 P.S.I. to 475° F. maximum. Paper insulated coils up to 180° F., glass insulated, silicone impregnated up to 475° F.

Write for Bulletin No. 100

ATKOMATIC VALVE COMPANY
525 ABBOTT STREET INDIANAPOLIS 25, INDIANA

For more information circle **95** on inquiry card.

NOW . . . IT'S NEW The only rectangular *illuminated* inspection lamp that frees both hands . . . enables use of both eyes . . .

SPEEDS UP INSPECTION!

For use in gear inspection . . . fine parts inspection, printing, engravings, fine assembly work, fine paintings, fine machine work, lathe work.

Check These Exclusive Features

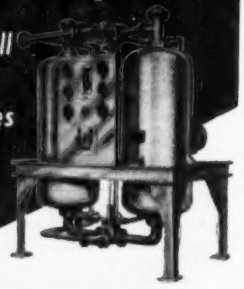
- Large clear field—6½" x 2½" Plane convex
- Attachments without base for use in lathe work available.
- Tilts to any angle
- Slides forward
- Relieves eye strain in close production inspection
- Lens focal length of—6 inches
- Heavy aluminum cast parts
- Precision ground polished lens
- 2 fluorescent 12-watt lamps

For complete information and illustrated bulletin, write;

ESCO PRODUCTS
1428 WILLOW AVENUE, HOBOKEN, N. J.

For more information circle **96** on inquiry card.

The Instrument Air Dryer
with all the features



★ Exclusive Finned System Desiccant Chambers
★ Automatic, Semi-Automatic, or Manual Control
★ Compact Functional Design (ASME Code)
★ Safety Interlock Control System
★ Atmospheric and Pressure Regeneration Circuits
★ Moisture Indicator and Instruments Panel Mounted
★ Superior Desiccant
★ Exit Dewpoint below minus 40°F at line pressure
★ Steam and Electric Reactivation

Submit your Dryer problems to our experienced instrument engineers.

SEND FOR *Illustrated Bulletin*

3170

Industrol CORPORATION
494 Westfield Avenue, East • Roselle Park, New Jersey

For more information circle **97** on inquiry card.

of d.c. This unit employs stationary coils with no slip rings; makes up to 350 lb.-in. torque available on output shaft. At recommended maximum input speed of 650 rpm., clutch element will transmit approx. ¾ hp. Each clutch element can continuously dissipate up to 50 watts of heat (much more for short intervals).—*Raymond Engineering Lab., Inc., Smith St., Middletown, Connecticut.*

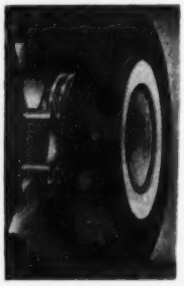
For more information circle **401** on inquiry card.

Metal Bellows

New ¼-in. and 5/16-in. diam. hydraulically-formed seamless metal bellows having a wide range of characteristics, are available in brass, phosphor bronze, beryllium copper and Monel. Most applications are as components of aircraft valves and switches.—*Bridgeport Thermostat Div., Robertshaw-Fulton Controls Co., Bridgeport 1, Conn.*

For more information circle **402** on inquiry card.

Teflon Bellows & Flanges



New corrosion- and heat-resistant bellows made from DuPont Teflon are available with companion flanges conforming to American Standard bolt hole circles and numbers for pressures to 125 psi.; can be supplied to fit any pipe size from ½ through 12 in. New convolution form is said to give greater strength, longer life and increased flexibility.—*Crane Packing Co., Dept. IUP,* 1800 *Cuyler Ave., Chicago* 13, *Ill.*

For more information circle **403** on inquiry card.

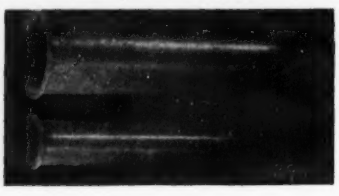
Sealed Rubber Terminals

New hermetic seal feed-through rubber terminals are formed of rubber-insulated copper-clad steel wire. Sealing by crimping a tinned copper sleeve over rubber insulation which is chemically bonded to wire. Oil leakage is prevented even at 30 psi. Terminals may be mounted on 3/16-in. centers; minimum overall length 1-5/64 in.—*Robco Mfg. Div., Pilot Int'l Corp.,* 27-01 *Bridge Plaza North, Long Island City* 1, *N. Y.*

For more information circle **404** on inquiry card.

Polyethylene Centrifuge Tubes

Two new polyethylene centrifuge tubes, 15-ml. conical bottom and 50-ml. round bottom, fit standard makes of

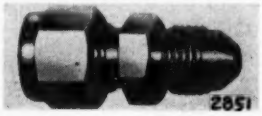


centrifuge heads; are virtually indestructible and leak-proof.—*The Nalge Co., Inc.*, 625 *S. Goodman St., Rochester* 20, *N. Y.*

For more information circle **405** on inquiry card.

Tubing Connector

New "Flare Connector" facilitates switching from flare fittings to "Swagelok" tube fittings; is equally



satisfactory for testing or permanent installations; is available in a complete range of sizes from ⅛ in. to 1 in. in brass, aluminum, steel, stainless steel, Monel and other machineable metals.—*Crawford Fitting Co.*, 884 *East* 140*th St., Cleveland* 10, *Ohio.*

For more information circle **406** on inquiry card.

Packing Gland

New "Model PG-5" pressure-seals entry of thermometers, thermocouple wells, Pitot and static pressure probes, round rods or tubes of any type, and insulated wires, without damage to round element, by compressing a soft sealant material such as Teflon, asbestos-graphite, and new "Conax Lava" seal.—*Conax Corp.*, 4515 *Main St., Buffalo* 21, *N. Y.*

For more information circle **407** on inquiry card.

Corrosion-resistant Fittings

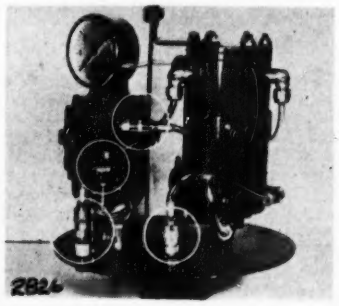
New line of corrosion-resistant screw-thread pipe fittings includes a

wide range of alloy metals; elbows, tees, unions and connectors for pipe from ¼-in. through ¾-in.—*The Special Screw Products Co.*, 5445 *Dunham Road, Bedford, Ohio*

For more information circle **408** on inquiry card.

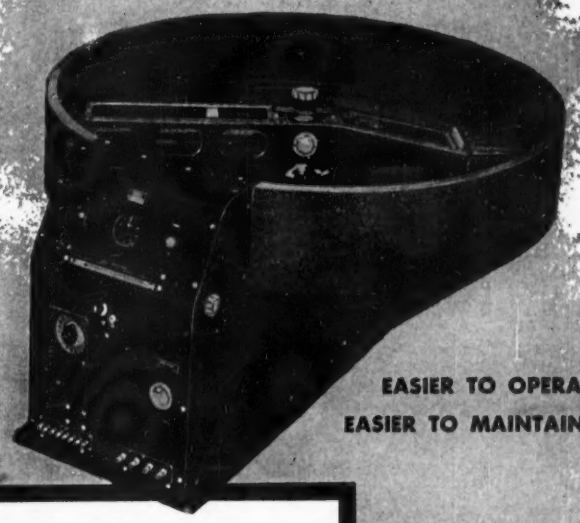
Air Tube Coupling

New "1A Pushomatic Quick Coupling," for test and check connections on air-operated instrument installa-



tions, provides a means for inserting or removing an instrument in a pneumatic circuit without disturbing system, without manually closing a valve

GENISCO'S MODEL B G-ACCELERATOR



EASIER TO OPERATE!
EASIER TO MAINTAIN!

Rugged, low cost unit provides fast, accurate calibration of accelerometers and other equipment under operational acceleration forces.

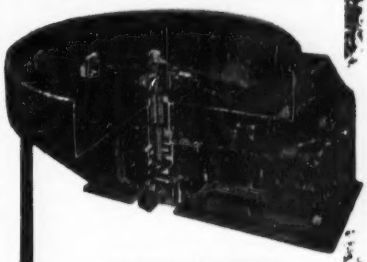
The mounting platform of the Genisco Model B, G-Accelerator accommodates instruments up to eight cubic inches in volume and 25 pounds in weight. Boom rotation is variable between 5 and 420 RPM, and is controlled by a single handwheel on the control panel. Maximum drift is less than 0.1% per minute, and maximum wow above 10 RPM less than 0.5%. The range of G-loadings is from .017 to 120 G's at the maximum radius of gyration of 24 inches.

Three separate instruments assure accurate RPM measurement!

A built-in, line frequency strobe disc system accurately measures boom speed at 82 harmonics over the full RPM range. In-between speeds can be determined by a counter-and-timer which counts boom revolutions, in any adjustable time interval, to the nearest 1/10 of a revolution. A standard aircraft sensitive tachometer, accurate within 1%, is also provided for rough speed indication.

Electrical leads have extremely low noise levels!

Eight solid silver slip rings are normally provided. These are designed for instrumentation rather than for power leads. Each is individually shielded and has a precious metal brush, resulting in noise levels so low oscilloscopes may be used at highly sensitive settings. Standard current carrying capacity of each slip ring circuit is 0.5 amperes continuous duty, with maximum resistance ¾ ohm. Combinations of power and instrumentation rings can be supplied.



OPTIONAL EQUIPMENT AVAILABLE

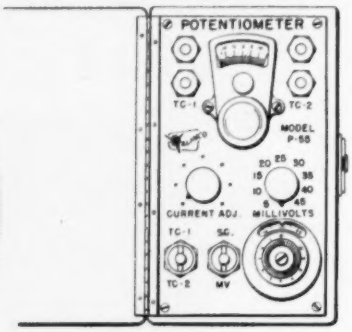
1. **OPTICAL SYSTEM**... for observing instruments while subjected to G-loadings.
2. **AIR SYSTEM**... four ¼", leak-proof pressure or vacuum ports for gas or liquids.
3. **OVERHEAD SLIP RING ASSEMBLY** ... provides additional power or instrumentation slip rings.
4. **ACCESS DOORWAY**... for ease in mounting test instruments.
5. **COVER ASSEMBLY**... conserves power by minimizing air pumping action, keeps dust out.
6. **DEEP GUARD RAIL**... 16" deep, provides more clearance above mounting table.

For detailed specifications on the Genisco Model B, G-Accelerator write to the Director of Sales, Genisco, Inc., 2233 Federal Avenue, Los Angeles 64, California.

Genisco
INCORPORATED

For more information circle **98** on inquiry card.

A miniaturized POTENTIOMETER



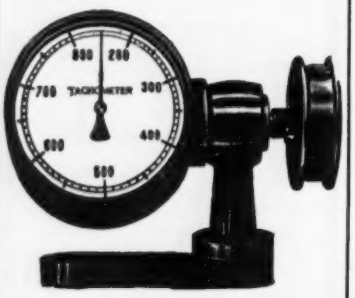
The miniaturized Potentiometer, Model P-55, weighs only three and one half pounds, and measures just 4 1/8 x 4 1/2 x 7 1/2 inches, yet is accurate to 0.02 millivolts. The dual input is equipped with an internal switch. The battery life is two years. $215.00

ALINCO

ALLEGANY INSTRUMENT COMPANY
incorporated
1000 Oldtown Road
Cumberland, Maryland

For more information circle **99** on inquiry card.

Amthor



STATIONARY TACHOMETERS

CENTRIFUGAL TYPE

Indicating R.P.M., F.P.M., etc.
Belt, Sprocket, or Flexible Shaft Drives

Models available for practically every requirement.

Immediate and intelligent attention will be given to your inquiries on all industrial speed measurement problems. Drop us a line today.

Amthor Testing Instrument Co., Inc.
49a Van Sinderen Ave. Brooklyn, N. Y.

For more information circle **100** on inquiry card.

King

MANOMETERS

Every Size-for Every Service

U-Type Manometers
- Single Cleanout
- Single Gland-Packed
- Double Cleanout
- Double Gland-Packed
- High Pressure

Well-Type Manometers
- Low Well
- Raised Well
- Barometric Reading

Multi-Tube Manometers
- Multi-Well
- Common-Well
- Special-Purpose

FREE LITERATURE gives sizes, construction and prices. Write today! And ask for informative 12-page Manual on Manometers.

KING ENGINEERING PRODUCTS include King-Gages — Pressure Transmitters — Sight Feed Bubblers — Overflow Check Valves — Air Flow Snubbers — Moisture Indicators

KING ENGINEERING CORP.
Box 70 • Ann Arbor, Mich.
REPRESENTATIVES IN PRINCIPAL CITIES

For more information circle **101** on inquiry card.

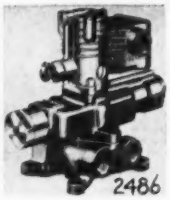
NEW INSTRUMENTS

and without using tools to disconnect a line; also eliminates 3-way valves. —*Breco Mfg. Co., Inc.*, 309 *E. Saratoga St., Baltimore, Md.*

For more information circle **409** on inquiry card.

VALVES

Pilot-operated Valve



New "Speed King Solenoid Pilot Operated Air Control Valve" meets JIC standards. All parts are totally enclosed. Junction box for electrical control is cast integral with pilot control housing. Stem in base and plunger in solenoid are only moving parts. Pressure range 35 to 200 psi. for air and low-pressure hydraulics. 2-, 3-, 4-, and 4-way-5-port (2-pressure) models; pipe sizes from ¼-in. to 1-in. Foot or sub-base (manifold) mounting optional. Any voltage and frequency.—*Valvair Corp.*, 454 *Morgan Ave., Akron* 11, *Ohio.*

For more information circle **410** on inquiry card.

Solenoid Valves

New "Bulletin 8338" cylinder-operated solenoid-pilot-controlled valves are for corrosive gases and liquids. Body material can be selected for

particular fluid. Standard valve is suitable for either N-O or N-C operation; is available with standard, watertight, or explosion proof solenoid enclosures; can be mounted in any position. Air, water, or oil for cylinder operation; pressure depends upon pipe size and auxiliary pressure available.—*Automatic Switch Co.*, 391 *Lakeside Ave., Orange, N. J.*

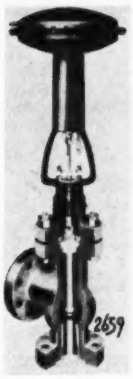
For more information circle **411** on inquiry card.

Bellows-seal Valves

Six new series of bellows-seal valves are announced: "1206" bar-stock needle valves and "1206-A" bar-stock globe valves in ¼-in., ⅜-in. and ½-in. sizes; "1206-C" needle and "1206-AC" globe valves with cast bodies in ½-in. to 2-in. sizes; "1212" diaphragm-operated control valves in ¼-in., ⅜-in. and ½-in. sizes for pressures to 500, 750 and 1000 psi. with one-, two- and three-ply bellows; "1215" diaphragm-operated on-off control valves in ¼-in., ⅜-in. and ½-in. sizes, featuring self-draining body.—*Associated Valves & Engineering Co.*, 1150 *W. Marquette Rd., Chicago* 21, *Ill.*

For more information circle **412** on inquiry card.

Balanced Control Valves



New "Seal-Balanced Angle Valves" are of maker's "Venturiflo" design with reduced turbulence, Venturi throat design, large flow capacity, etc. Force caused by line pressure against plug cross-sectional area is cancelled by means of a hole drilled along axis of plug, intersecting radially-drilled holes near top. Thus, line pressure exerts a downward force on plug equal to upward force. Valve may be positioned accurately at pressure differentials as high as 3600 psi. with standard superstructures actuated by standard instrument air output. Sizes 1-in. to 8-in.; temperature rating 450 F.—*Hammel-Dahl Co., 175 Post Road, Providence 5, R. I.*

For more information circle **413** on inquiry card.

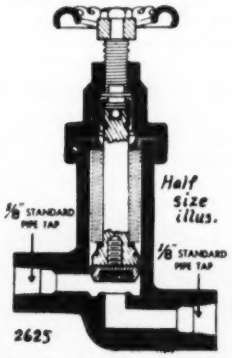
Angle Valve

New "Model AM Demi" packless angle valve has male inlet connection and female outlet connection. Same packless construction can also be supplied in straight-through design with multiple ports or in a 2 or 3-valve manifold in brass, aluminum, steel and 303 SS. Each can be equipped with panel mount bonnets, tee handles or round handles (as shown), toggle-actuated, or with diaphragm operators.—*G. W. Dahl, Bristol, R. I.*

For more information circle **414** on inquiry card.

Bellows-type Packless Valve

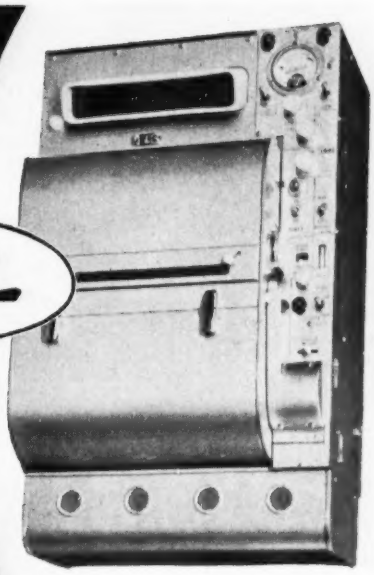
New bellows type packless valve is available in hand-operated or pneumatic-hydraulic models for vacuum,



high-pressure, high-temperature and low-temperature systems. Hand valve features a ball joint to prevent torque transmitted to bellows and stem. Pneumatic-hydraulic model is suited for multiple manifold set-ups and remotely operated valves. Standard models

NEW! Revolutionary Heiland

Model 700C Multi-Channel Oscillograph



MODEL 708C

...for Dynamic Data Recording

The complex phases of modern testing programs demand that test instruments be advanced far beyond today's requirements.

Heiland has continued to meet the challenge by progressive improvements in their products, and now take pleasure in announcing their most recent contribution—the 700C.

Heiland's New 700C Oscillograph is available in two models: The 708C which records up to 36 channels on 8 inch recording media; The 712C which provides up to 60 channels using 12 inch media. Record speeds as high as 144 inches per second or as low as .030 inches per second are made readily available through rapid change gears. In addition, any one of four separate record speeds with automatic recording intensity control may be selected from the operating panel even while a record is in progress. This permits "jump speeds" having 2:1, 4:1 and 8:1 ranges which has long been a standard Heiland feature. Remote operation of the jump speed, which was previously installed on special order, is now standard. A new optical system provides more than adequate recording intensity for the highest writing speeds. Provision is made for operation of the same instrument from 28 Volt DC, 115 Volt 60 cps, or 115 Volt 400 cps power.

The 700C accommodates Heiland's New Sub-Miniature Galvanometers and temperature controlled magnet assemblies.

The New Sub-Miniature Galvanometers are exceptionally stable yet offer the highest in sensitivity. A partial galvanometer listing is as follows:

Type	Frequency Response	Milliamperes per inch
M40-350	0-24 cps	.00424
M100-350	0-60 cps	.00551
M400-120	0-240 cps	.0678
M3300	0-1980 cps	25.4
M5000	0-3000 cps	33.9

See these and other Heiland instruments at

Booths 332 and 334
ISA Exposition
Philadelphia, Pa., Sept. 15-21

Heiland 20TH ANNIVERSARY

Heiland Research Corporation 130 EAST FIFTH AVE DENVER, COLORADO

For more information circle **102** on inquiry card.

NEW

DALL Low-Loss FLOW TUBE

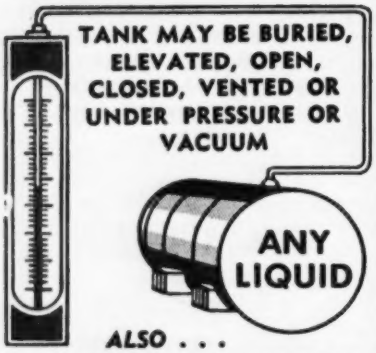
This primary metering device produces important pumping economies by reducing meter head loss to a minimum. Very short laying length — only 1½ to 2 pipe diameters. Lightweight and easy to install. Meters very accurately with regular differential-type instruments. Send for Bulletin 115-L1. Builders-Providence, Inc., 422 Harris Avenue, Providence 1, Rhode Island.

BUILDERS-PROVIDENCE
DIVISION OF BIF INDUSTRIES, INC.
METERS FEEDERS CONTROLS

See us at the Instrument Exposition in Philadelphia

For more information circle **103** on inquiry card.

TANK-O-METER
FOR MEASURING TANK CONTENTS ANY DISTANCE AWAY



ALSO . . .
HYDROSTATIC GAUGES
FOR ALL PURPOSES
PRESSURE • VACUUM • DRAFT
DEPTH & ABSOLUTE PRESSURE
DIFFERENTIAL PRESSURE
MERCURIAL BAROMETERS

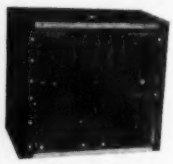
SEND FOR BULLETINS

UEHLING INSTRUMENT CO.
470 GETTY AVE., PATERSON, N. J.

For more information circle **104** on inquiry card.

PHASE ANGLE COUNTER

0.00001 CPS to 1000 CPS
ACCURACY ± 1 COUNT PER 100,000


TYPE 1011-2-6

Consists of Type 1011 decimal counters and switching circuit unit, Type 1106 timing unit and Type 1102 function unit. Other plug-in units permit quick change to frequency counter, time interval counter, or Universal time interval and frequency counter.

PRICE $918.00

WRITE FOR DATA!

ADVANCE ELECTRONICS CO., INC.
451 HIGHLAND AVE.
PASSAIC, N. J.

For more information circle **105** on inquiry card.

NEW INSTRUMENTS

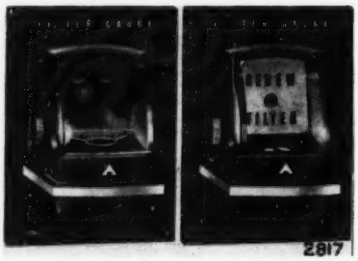
rated up to 150 psi. (with minor modifications for much higher pressures); temperature from –65 F. to 250 F. in standard models, greater extremes with small modifications on special order. Bellows of corrosion-resistant metals can be furnished. Pneumatic-hydraulic operated model operates on 10 to 150 psi.; valve seat is spring loaded to open when actuating pressure is released.—*Clifford Mfg. Co., Grove St., Waltham 54, Mass.*

For more information circle **415** on inquiry card.

MISCELLANEOUS

H&V-system Filter Gage

New "one-piece" low-cost filter gage for forced-air heating, cooling, and ventilating units determines filter's resistance to free passage of filtered



air as well as its capacity to clean the air; automatically indicates when filter has become dirty and should be replaced.—*Bacharach Industrial Instrument Co., 7301 Penn Avenue, Pittsburgh 8, Pa.*

For more information circle **416** on inquiry card.

Contact Cleaners

New "Tuneraser" and "Q.T." provide cleaning, lubricating and preserving function for tuners, contacts and any moving or sliding parts. "Tuneraser" is a chemical stick: material formed as an eraser for easy handling, designed expressly for removing tarnish and corrosion from contacts, without danger of abrading surface. ★ "Q.T." liquid cleaner and "preservator" is supplied with an applicator in a 3-oz. bottle.—*Superex Electronics Corp., 23 Atherton St., Yonkers, N. Y.*

For more information circle **417** on inquiry card.

Indicating Fuse-holder

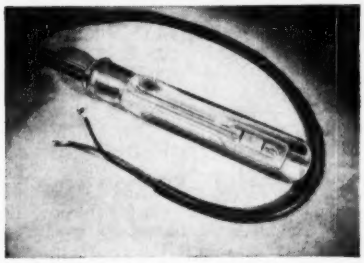
New "Fuse-Lamp" holds a 3 AG type fuse (1¼ x ¼ in.) and, when fuse burns out, neon glow lamp lights. Extends 2 in. back from mounting

panel; weighs 1¼ oz.; mounts in a 27/32 in. hole. Avaliable with neon lamp, 60 to 500 v. ac-dc., or with incandescent lamp, 2½ to 60 v. ac-dc.—*L. Keller, 3547 N. Wilton Ave., Chicago 13, Ill.*

For more information circle **418** on inquiry card.

Conductivity Cells

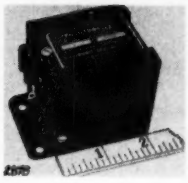
New conductivity cells of jacketed type for dip-use are designed for laboratory conductivity measurements



under specific temperature requirements. Pyrex glass tapered stopper is integral portion of cell, and oversize special test tube serves as jacket. Cell is available in constants from 0.01 to 100.—*Industrial Instruments, Inc., 89 Commerce Rd., Cedar Grove, N. J.*

For more information circle **419** on inquiry card.

Pulse Generators



New "Pulsitometers" for use as flashers or keyers in fire detection circuits of jet aircraft which utilize a single warning light to indicate both conditions or two detection points, are available in several models to cover various circuits and a wide range of flashing rates.—*Electronic Specialty Co., Contract Div., 3456 Glendale Blvd., Los Angeles 39, Calif.*

For more information circle **420** on inquiry card.

Tape-recorder Inverter

New inverter is said to turn any automobile into a "rolling office"; makes it possible to dictate reports or other material on any type of dictation machine; operates from 6- or 12-volt battery and provides 110 v.ac. for operating recorder; is available with mounting brackets for (1) underdash, or (2) trunk mounting with remote control unit.—*American Television and Radio Co., 300 E. 4th St. St. Paul, Minn.*

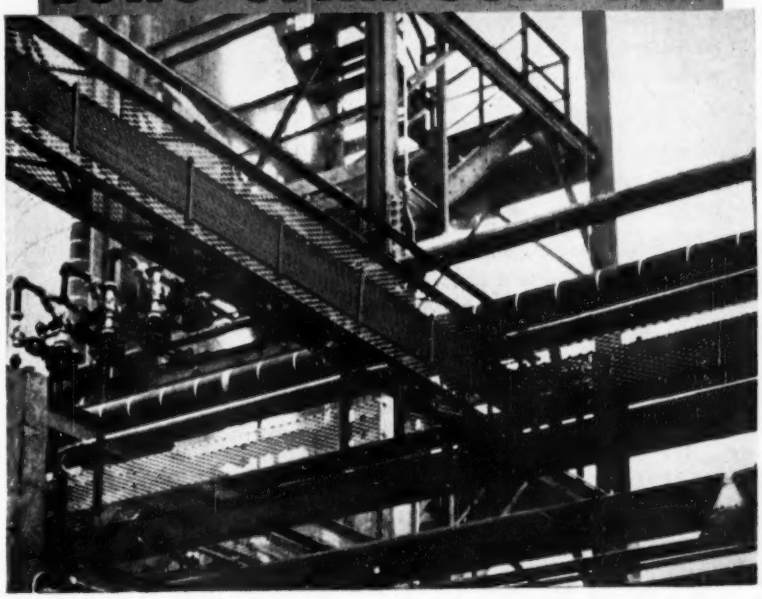
For more information circle **421** on inquiry card.

Intercom

New "LCM-8806" six-station wireless master intercommunications system, requiring no cables or installation (plugs into electric outlet) is presented as "the first completely selec-

INSTROF®

instrument Tubing Trough has become a LONG SPAN SUPPORT



Completely fabricated flattened expanded metal Instrof now not only offers a full system for supporting instrument tubing but a system (as shown in this photograph) for spans up to 32 feet.

This is just one of the recent Instrof developments which are described in a new 12 page, 2 color catalog. Be sure to write for it today.

INSTROF INCORPORATED

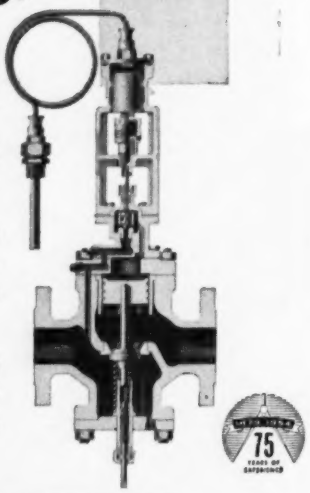
4923 PENTRIDGE ST.
PHILADELPHIA 43, PA.

For more information circle **106** on inquiry card.

FOR CONTROLLING TEMPERATURE OF LIQUIDS OR GASES

TEMPERATURE REGULATORS

FOSTER TYPE T



Foster manufactures a complete line of temperature regulators for all types of service—for hot water storage heaters, fuel oil heaters, pasteurizers, ovens, driers, cookers and other process heating and cooling equipment.

They are available in single or double-seated construction; direct or reverse acting; in combination with pressure reducing valves; and in proper materials for the type of service.

Like all Foster valves, they are designed and built for long life with a minimum of maintenance, and are easy to service when necessary. Ask for Bulletin T-101.

FOSTER ENGINEERING COMPANY

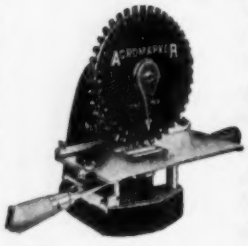
835 LEHIGH AVENUE — UNION, N. J.

AUTOMATIC VALVES • SAFETY VALVES • FLOW TUBES

For more information circle **107** on inquiry card.

STRAIGHT
LINE NUMBERING ON ANY METAL OR MATERIAL

FAST



Lots of Power for Nameplate or Parts Marking

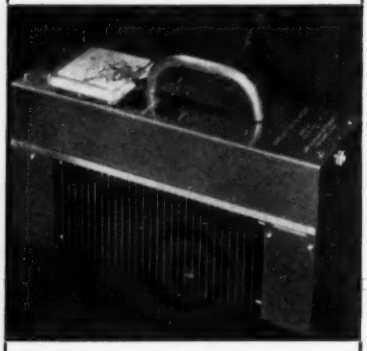
The Famous ACROMARKER Name-Plate and Parts Stamping Machine is built for hard service. Fills-in name plates or makes your own from scrap. Easy to use and widely adaptable. Comes in several models 1/16" dies to ⅜". Write for ACROMARKER data.

The ACROMARK Company

3-11 MORRELL ST.
ELIZABETH 4, NEW JERSEY
"The Original Marking Specialists"

For more information circle **108** on inquiry card.

MERCURY VAPOR DETECTOR
for detecting the toxic vapor given off by mercury



The toxic limit is a full scale reading on the high sensitivity scale of Model 23, illustrated above. The weight is 7 pounds and the size is 13 x 8½ x 4½ inches.

A bibliography on the mercury vapor hazard is available on request as well as literature on the different models of the Kruger Mercury Vapor Meter.

HAROLD KRUGER INSTRUMENTS
Box 164 — San Gabriel, Calif.

For more information circle **109** on inquiry card.

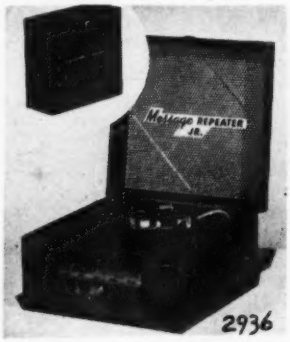
NEW INSTRUMENTS

tive wireless intercom system." Six-channel selector enables each unit in system to transmit to any of the six separate channels and receive calls on any channel it selects to use. Three separate conversations can be carried on simultaneously over six-station system.—*Talk-A-Phone, 1512 S. Pulaski, Chicago, Ill.*

For more information circle **422** on inquiry card.

Automatic Spoken-warning Safety System

New "Message Repeater Junior" is 8 in. long, plays back safety warnings through a 5-in. external speaker. Pre-

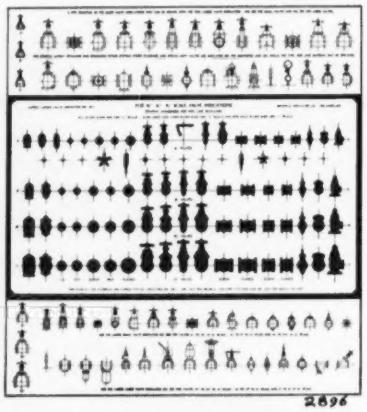


pared messages are recorded on a mag-tape cartridge the size of a pack of cigarettes. Cartridges are interchangeable.—*Mohawk Business Machines Corp., 944 Halsey St., Brooklyn, N. Y.*

For more information circle **423** on inquiry card.

Valve-drawing Templates

New "Small Valve Indicator #255" and "Large Valve Indicator #257" drafting templates cut time and cost in drawing standard and special duty



valves, are accurately made for ⅛-in., ¼-in. and ½-in. scale; any type valve, variable pipe connections. Actual size 5⅜ by 9⅞ in.—*Graphic Indicator Co., 1739 S. La Cienega Blvd., Los Angeles 35, Calif.*

For more information circle **424** on inquiry card.

Audiometer

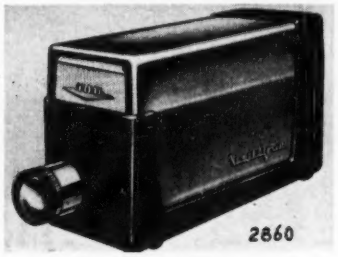
New audiometer is said to provide "the most reliable testing ever offered to the nation's 15 million hearing loss victims" and to be "easier to keep in

calibration than any previous audiometer." Among features: can test up to 40 persons at one time; weight is less than 14 lbs.; designed to surpass AMA standards; simplicity of design means easier operation and maintenance as well as a 25 percent reduction in price from previous levels; no distracting clicking sounds when hearing loss dial is turned; calibrated masking tone, one bone conduction and two air conduction receivers for individual testing; automatic equalizer for group testing.—*Beltone Hearing Aid Co., 2900 W. 36th St., Chicago, Ill.*

For more information circle **425** on inquiry card.

Industrial TV

New "Series 400 UtiliVue" camera can be used either with a video monitor or with a standard TV receiver; can be tuned to any channel from



2 to 6. All controls and power supply are built-in. Automatic illumination compensation. Either "Utilicon" (long-life cold-cathode) or "Vidicon" type pickup tube. (Distributed by Graybar Electric Co.)—*Diamond Power Specialty Corp., Lancaster, Ohio.*

For more information circle **426** on inquiry card.

All-weather Camera Box

New all-weather TV camera box enables permanent camera installations out-of-doors, in hazardous loca-

tions; has adjustable bed-plate for 2-, 4- and 6-in. lenses. Thermopane window (through which camera takes pictures) has remote-controlled inside and outside windshield wipers.—*Tenney Engineering, Inc., 1090 Springfield Rd., Union, N. J.*

For more information circle **427** on inquiry card.

Charger for "Silvercel"

New battery charger for Yardney "Silvercel" comprises a magnetic reference accurate to 0.2 percent and a stable high-gain low-level magnetic amplifier. Once battery is fully

Sorry . . .
A. W. HAYDON CO.
can't help you.

Only instruction, practice, and patience can improve your score!

But . . . if your problem is PRECISION TIMING

you may save time, trouble and money by investigating what our timing engineers have done for others. Our A.C. and D.C. achievements may already include the solution of your most complex problem. Why not find out?

Send for latest catalog manual

The A.W. HAYDON COMPANY
228 NORTH ELM STREET
WATERBURY 20, CONNECTICUT
Design and Manufacture of Electrical Timing Devices

For more information circle **110** on inquiry card.

RECORDING CHARTS MADE TO ORDER

With so many variations of recording techniques, TECHNICAL'S engineering staff has been asked to develop and manufacture hundreds of "special" recording charts. Other situations in which standard instruments are recording under unusual process conditions have received the experienced attention of this "special" staff.

Both industry and instrument makers have made use of the wide experience offered by Technical. General Motors Research Laboratory, E. I. DuPont de Nemours Company, Inc. and National Bureau of Standards and many others are "Special" users.

Write for Technical's bulletin of "Special" services.

TECHNICAL CHARTS INCORPORATED

181 VAN RENSSELAER ST. BUFFALO 10, N. Y.

Nationally Represented by TECHNICAL SALES CORPORATION, 16599 Meyers Road Detroit 35, Michigan

For more information circle **111** on inquiry card.

Weighing Systems

by Pneumatic Force Balance

PROVIDE AUTOMATION FOR THE CONTINUOUS OR BATCH PROCESS.

A complete line of weight transmitters in single and multiple diaphragm construction with load capacities up to 23,000 pounds per diaphragm. Pneumatic tare balance for any portion of the total load on all models. All moving parts are enclosed totally. Complete weighing systems designed to your requirements.

WRITE FOR CATALOG

JOHN R. MONSELL COMPANY
Pitman, N. J.

For more information circle **112** on inquiry card.

High Precision Optical Components Any Size For Astronomical and Physical Research

•

Parabolic, Spherical, Ellipsoidal and Plane Mirrors

•

Plane Parallel Plates

•

Schlieren Systems

•

Wind Tunnel Optics

•

Lenses & Prisms of Glass Natural or Synthetic Crystals

•

Complete Optical and Mechanical Instruments

•

Made to Specifications

•

High Vacuum Coating

•

John Unertl Optical Co.

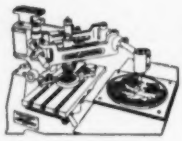
3551-3555 East Street
Pittsburgh 14, Penna.

For more information circle **113** on inquiry card.

PREIS 2 and 3 Dimensional
ENGRAVING MACHINES
& Accessories

Designed for fast-easy engraving, etching and electric marking of lettering, design, calibrating and numbering on parts and instruments of any metal, plastic or other material.

Model 2D-4



You're always safe in buying PREIS-*PANTO engraving machines and accessories.

Model 3D-5

Model CG

Model CG Cutter Grinder for grinding, engraving and routing cutters.

*PANTO Master Copy Type Cutters Collets for all types of Engraving Machines available.

Write for new color folder of the entire PREIS-*PANTO line.

PANTO

*TRADE MARK Reg. U.S. Pat. Off.

H.P. PREIS Engraving Machine Co.
661 U.S. H'Way 22 **Hillside, N. J.**

For more information circle **114** on inquiry card.

NEW INSTRUMENTS

charged, charger cuts off entire apparatus from line; cut-off voltage is within 1 percent of rated battery voltage despite line voltage variation of 25 percent and frequency fluctuation between 55 and 65 cps. Approx. dimensions: 8 x 10 x 12 in.—*Magnetic Precision Controls, Inc., 119 W. 63rd St., New York 23, N. Y.*

For more information circle **428** on inquiry card.

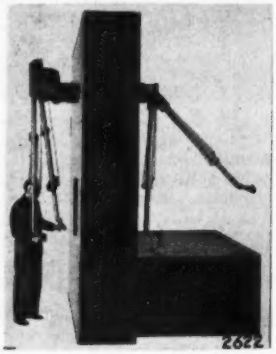
Non-magnetic Scissors

New "SHHears," of interest to those who use tape recorders, is a non-magnetic scissors which cuts tape or magnetic sound tracks without leaving a static blip.—*Gordon Instruments, 6009 W. Pico Blvd., Los Angeles 35, Calif.*

For more information circle **429** on inquiry card.

Remote Manipulator

New "Model 8 Master-Slave Manipulator" features electrically-driven canting mechanism that permits angular position of slave end to be varied



independently of master end. Operator can bring specimen up to viewing window without backing away; and mechanism automatically raises slave end to horizontal, so that manipulator arm may be removed easily from barrier wall for repairs or repositioning in another cell.—*Dep't KP, Central Research Labs., Inc., Red Wing, Minn.*

For more information circle **430** on inquiry card.

Mechanoelectrical Pulser

New "B 7000 Impulse Generator," said to be first of its kind, converts mechanical energy into electrical pulses; was originally developed for military aircraft to set off explosive charges for emergency ejection; has many industrial applications wherever an electrical impulse is required and only slight mechanical force is available. Unit is self-restoring after operation without application of additional mechanical force. It operates successfully under water in marine applications, etc. It has no stored-en-

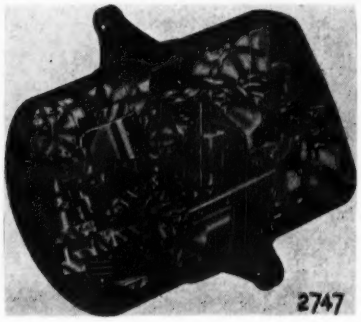
ergy devices such as spring-loaded assemblies to cause unintentional operation. Illustrated unit delivers 5½ watts power for pulse duration of 25 milliseconds or longer with fast rise time; weighs 2.6 lbs. Size, shape and weight may be varied; hermetic sealing available.—*Microloc*, 5811 *Marilyn Ave., Culver City, Calif.*

For more information circle **431** on inquiry card.

AIRCRAFT INSTRUMENTS

Reference Gyro

New "Model 221" airborne reference gyro accelerates to operational control speeds in 10 seconds; withstands extreme acceleration and shock up to 60 *G*; measures displacement about



two axes by means of a pickoff placed on each gimbal axis. Use of an electrically operated caging device permits caging cycle to be completed in 4 sec. for normal displaced positions; with gimbal displaced 180 deg., maximum caging time is 20 sec. Gyro can be completely uncaged in less than 0.1 second.—*Summers Gyroscope Co.*, 2328 *Broadway, Santa Monica, Calif.*

For more information circle **432** on inquiry card.

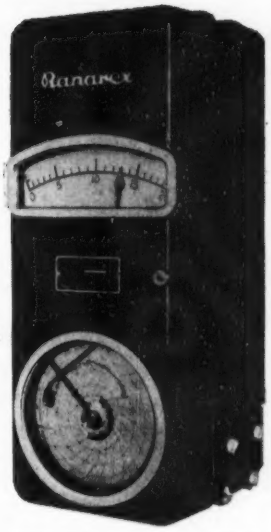
Sky Compass

New design of sky compass, said to be "the first practical instrument for accurate aerial navigation in high latitudes," operates on principle that

maximal polarization of sky's light is at right angles to incident beam from sun; thus gives true heading of an aircraft by determining position of sun when sun is below horizon. New compass is most accurate in polar regions, where it is also most useful, because of long twilight periods in these regions and ineffectiveness of magnetic compass at high latitudes.—*Kollsman Instrument Corp.*, 80-08 45*th Ave., Elmhurst, N. Y.*

For more information circle **433** on inquiry card.

FOR
FAST GAS ANALYSIS



RANAREX®

Indicates, Records, Controls

• Combustion Gases • Chemical Process Gases • Petroleum & Refining Gases • Inert Atmospheres • Gas & Gas/Air Mixtures • Heat-treating Atmospheres • Gas Specific Gravity

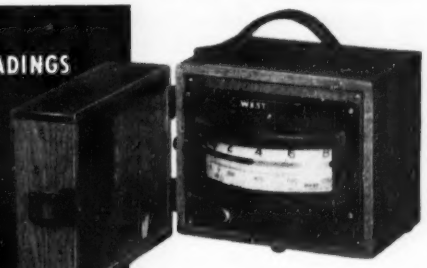
ADVANTAGES!
High Accuracy
Continuous Measurement
. . . Short Lag
Simple Principle
Rugged Construction

A PERMUTIT® PRODUCT

Write today for **FREE** Technical Bulletin
The Permutit Company, Dept. I-9
330 West 42nd Street, New York 36, N. Y.

For more information circle **115** on inquiry card.

ACCURATE TEMPERATURE READINGS
WHEREVER AND
WHENEVER WITH
Veri-tell
PORTABLE
PYROMETERS BY WEST



These rugged, handy precision-built instruments are widely used for taking spot readings where permanent installations are needless and for checking other instruments. Each mounts a Veri-Tell high resistance pyrometer in a gasketed aluminum housing, itself contained in practical Oak Case with lock and handle. Quick, positive service is assured by binding posts for attaching thermocouple. Automatic meter shunt protects meter when case is closed. Fully *guaranteed* and surprisingly *low priced*. Write for Catalog IE-1.

Many standard and special thermocouple assemblies including hand probes are available to permit reading—

- Surface temperature of dies, etc.
- Temperature of non-ferrous molten metal
- Immersion temperature of hot oil, wax, solder pots, etc.

ASK YOUR DEALER

WEST Instrument
CORPORATION
CHICAGO
SALES OFFICES IN PRINCIPAL CITIES

527 North Noble Street Chicago 22, Illinois Phone Taylor 9-6606

For more information circle **116** on inquiry card.

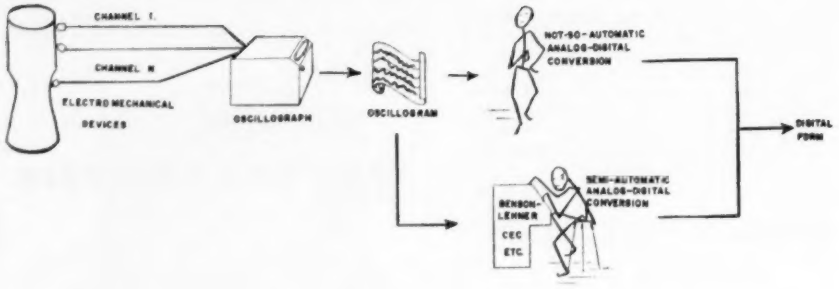


Fig. 1. Today's two basic methods of data handling.

Definite philosophies on data handling—conversion of large quantities of measured data into information upon which action can be taken—have developed. One method is analog recording of signals and low-speed conversion to digital form from storage. The other method is an online analog-to-digital conversion with digital recording and storage. This survey presents the newest concepts in handling of data.

Survey of INTEGRATED DATA-

WHERE large quantities of data must be handled they must be reduced to a form where engineering personnel can have a basis for action. In most industrial and research institutions the number of measurements is increasing, and the two basic problems involved are (1) low cost and (2) short time. Distinct philosophies have emerged on how to use data-handling apparatus to accomplish this task.

Presented at Los Angeles Section Meeting, ISA, June, 1954.

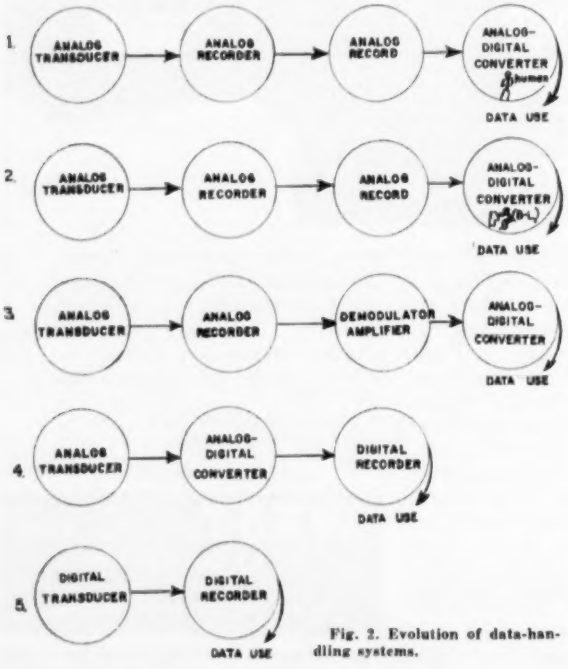


Fig. 2. Evolution of data-handling systems.

Basic Techniques

Fig. 1 shows conventional techniques, which can be represented in block form as techniques 1 and 2 in Fig. 2. (Fig. 2 may well be a picture of the past, present, and future of the large-scale handling of data.) Technique 1 of this figure is the practice used by Michael Faraday in 1722, with which he succeeded in the course of some ten years in showing that an electrical charge could be induced on a laundry pail. The procedure consists of making an analog measurement of the phenomenon under consideration—that is, a point-by-point recording of the phenomenon in terms of a continuous analogy, much like the deflection of a recorder pen is an analog recording of, say, temperature. With the help of strong eyesight and keen nerves, one can measure this line from a base line and convert the displacement into a number, thus reducing the analog signal into a digital signal.

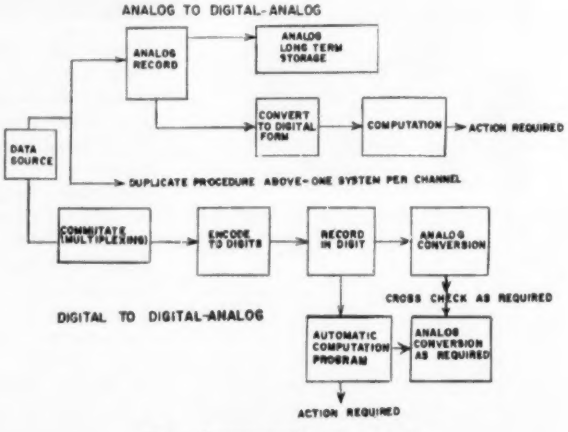


Fig. 3. Present analog-type systems.

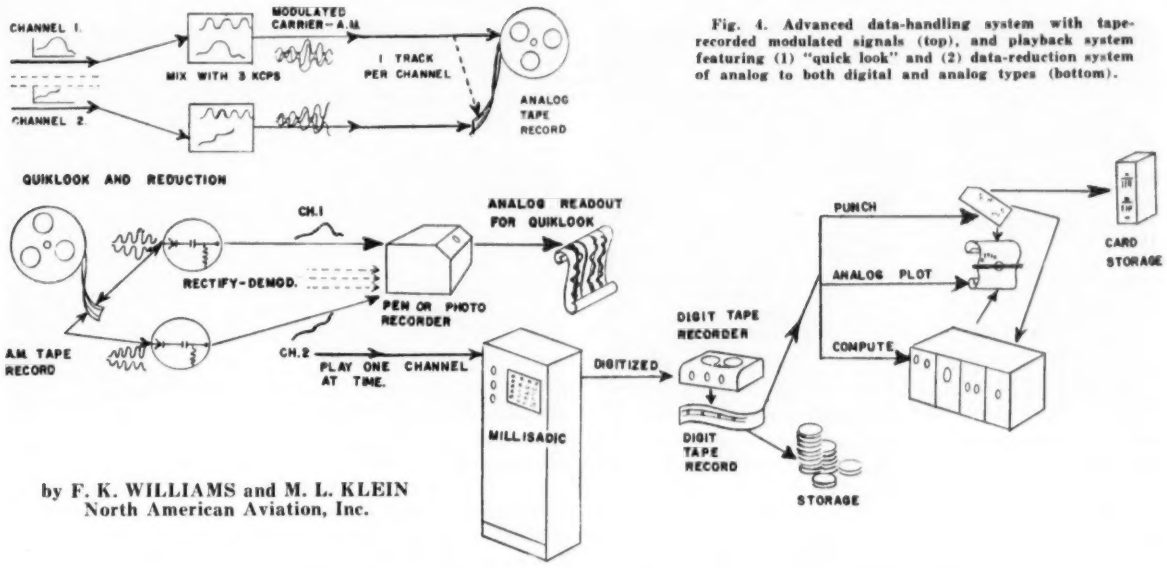


Fig. 4. Advanced data-handling system with tape-recorded modulated signals (top), and playback system featuring (1) "quick look" and (2) data-reduction system of analog to both digital and analog types (bottom).

by F. K. WILLIAMS and M. L. KLEIN
North American Aviation, Inc.

CONVERSION SYSTEMS

More recently, technique 2 became available. This is essentially a method of eliminating tedium by inserting in the process a device which converts the analog record into digits with the help of a human operator. Existing equipment can be bought to do this.

With a little ingenuity, one arrives at the philosophy of technique 3. Here the analog record is run through suitable circuitry (now available) and is converted automatically but at low speed into digits by a semi-mechanical, semi-electronic converting device. This system can be constructed from existing shelf equipment.

In technique 4 we arrive at a current development more in keeping with the problem itself. Here the analog signal is converted instantaneously into digits by circuitry, with rapidity and accuracy; then the digits are recorded. This type of equipment is available also.

Finally, technique 5 shows a method whereby the transducer itself, by some means, converts the measurement into digital form which then is recorded immediately. This represents the future more than the present, but is inevitable according to current thinking.

Comparison of Basic Methods

Techniques 4 and 5 differ from 1, 2, and 3 in a basic and important respect. In 4 and 5 the signal is *recorded* in digital form, whereas in 1-3 the recording is in analog form.

Refer to Fig. 3. Here a common data source feeds both types of systems. The top system is an analog-recorded system which then either converts the signal to a digital representation or reproduces the analog signal from storage. Each channel measured in this method requires a complete system as shown, one recorder per channel. A common digital converter can be used since the channels are fed into the converter one by one at some later time from the analog record (this latter can be a tape recording). Ultimately, the digits can be run into a computing machine and the reduced data obtained.

An *online digital system* is shown in the bottom half of the figure. Here we introduce the notion of multiplexing, or time sharing of a common circuit with several inputs. This is analogous to a seat on a bus in which one chair is used by many different people at many different times, but no two at the same time. Here all of the channels are run into a commutator, or multiplexer, which examines the channels in succession. From there each signal is individually processed. First the signal from each channel is encoded—that is, circuitry is provided to turn the analog signal into a digital representation. Finally the digital code is recorded in the form of pulses on tape. This is also a conventional pulse tape recorder. This tape is used to make computations or punch cards, or for storage. It can also be run into a standard piece of equipment to reproduce an analog signal of the input voltage, if desired.

New Tape-Quicklook-Card Method

Recording

Fig. 4 is an illustration of a specific method being developed by one manufacturer. This method hinges on the operation of a relatively-low-speed analog-to-digital converting machine (a shelf item). Reading from the upper left and following the arrows, the recording sequence is shown. Each channel is modulated so that it becomes the envelope of a 3-kc. carrier frequency. (This modulation is necessary to circumvent the inherent phase distortion introduced in the equalization networks of tape recorders.) The modulated 3-kc. carrier is recorded, one amplifier and tape track required for each input channel. One now has an analog representation of the measured phenomenon.

Quicklook and Reduction

The tape is played back through a demodulation circuit which eliminates the carrier frequency. This is done at considerably slower speed than that at which the signal is recorded. This allows one to reproduce the signal on analog recorders of low-frequency response, such as a pen or photo recorder. This analog readout is examined by the

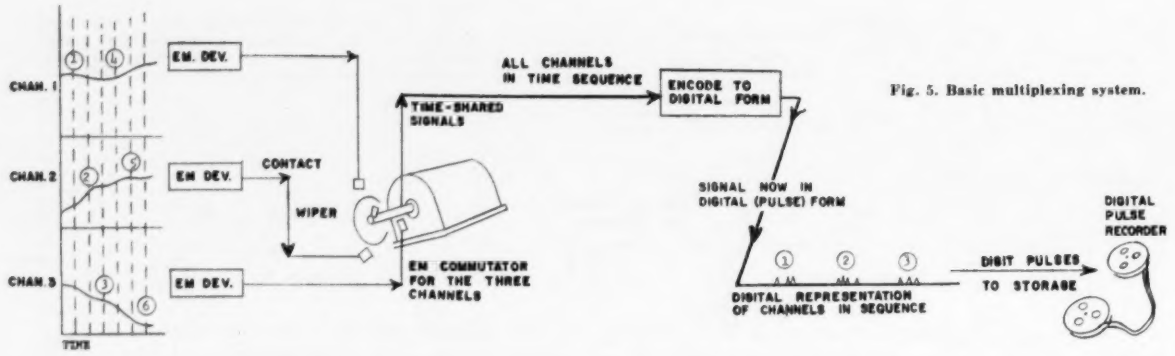


Fig. 5. Basic multiplexing system.

project engineer and given a "quick look." He then decides which channels are worth investigation. Those chosen channels are re-run from the tape into the slow-speed converter and the signal is converted at this slow speed into a digital form. This can be either tape recorded again and stored in digital form (digit-recorded tapes have better storage properties than analog-recorded tapes) or any of several alternates such as computation by machine, or punch cards, etc., can be chosen.

The important thing here is that the signal is recorded in analog form and then converted at slow speed into digital form for any of several uses. We have here the "*quicklook*" concept which permits the project engineer at all times to supervise the data reduction and perform only those operations essential to investigating abnormal operations. This philosophy is the only sound way to manage the processing of large quantities of data.

Multiplexing

Fig. 5 is an outline of the multiplexing system in a mechanical form preparatory to detailing an electronic multiplexing arrangement. Three signals from three channels are shown in analog form as produced on a measuring instrument; any number of channels can be used. Each of these signal voltages appears at a contact point. As the motor turns the wiper, each channel has its circuit completed for a part of the revolution of the motor. This is *commutation*. With this arrangement, each channel is fed in succession to a common encoding device, which instantaneously converts the signal (received in analog form) into its equivalent digital representation. This instantaneous conversion is called *online analog-digital conversion*. Notice that the encoding device is used sequentially by each of the channels and only a single encoder is required. The conversion results in pulses which represent binary code, quinary code, binary decimal code, etc. Finally, these pulses are recorded on a pulse tape recorder (shelf equipment).

The advantage of this arrangement is that analog signals are not stored on tape as easily as pulse signals. Pulse recording has high rejection of noise, whereas analog does not. This basic system of online digital conversion is being adapted for complex guidance problems, and allows the maximum time utilization of a minimum of equipment by multiplexing.

Fig. 6 is an actual system based on this multiplexing arrangement. Each of the signals is fed in on a separate channel in analog form. Commutation is performed by a unique all-electronic circuit using a logical network and time-based matrix. Therefore, we have a sequential high-speed analog signal being fed to a common line from each input channel in turn. How often a channel must be multiplexed is determined by the frequency requirements for a channel (readily determinable from information theory). Moreover, this electronic commutation arrangement can be patched to change the bandwidth of any channel arbitrarily, provided the sum bandwidth of all channels does not exceed the total of the design (say 500 kc.). We can patch for, say, 500 channels of 1000 cps. each, or 100 channels of 5000 cps., or anything within reason and the number of patch plugs available. These individual chunks of analog voltage that are visited are next clamped in a circuit called a *recycling detector*, which holds the analog voltage long enough (a few microseconds) for the encoding. This is like a high-speed register device which instantaneously isolates the signal from everything else going on so it is a definite value at a given time even though the signal is itself changing. This is then encoded in a standard weighting matrix to give a binary-coded train of pulses which can represent any number between 0 and 128. This requires seven pulses per encoding. Finally, this is recorded on a standard pulse-recording device. From this point, somebody decides what to card punch, compute, etc.

All data is available instantaneously for investigation. A simple investigative procedure for routine work is to set tolerance on any and all characteristics, and patch these tolerances into a high-speed digital-computing machine. The tape is then run back into the computing machine; only those channels which exceed tolerances are recorded. Thus, the basic rejection is done for the engineer and he can consider the significance of only those channels which are out of established limits.

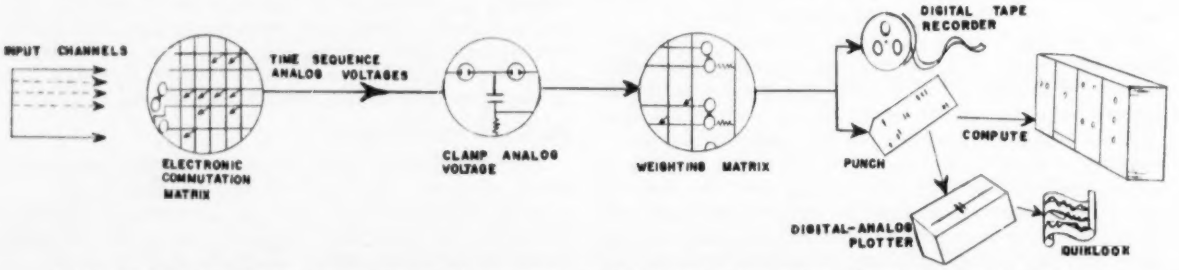


Fig. 6. Proposed data-reduction system with digital input and both digital and analog output, featuring electronic multiplexing.

Fig. 1. Over-all view of the new Beckman & Whitley wind tunnel designed for instrument test and calibration. Major construction is of timber and plywood.

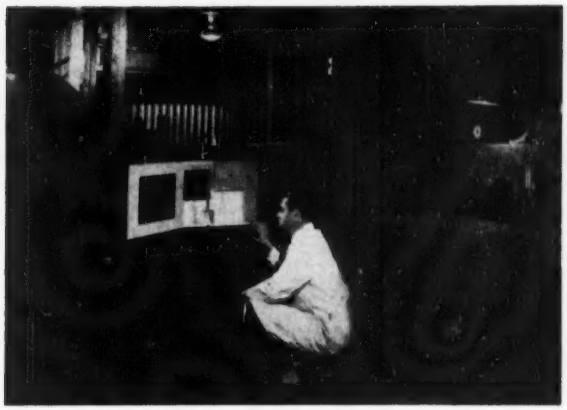


Fig. 2. Close-up of wind-tunnel throat with an electronic anemometer unit in test position. In addition to the front and rear observation points visible, a third viewing window is located in the top surface.

Calibration Wind Tunnel

Calibration of anemometers requires a small but versatile wind tunnel.

by ROBERT C. NYDEN
Beckman & Whitley, Inc.

DEVELOPING and manufacturing an electronic anemometer for measuring air speeds down to 0.5 mph. requires a means for calibrating and checking finished instruments conveniently and accurately. This calls for a small wind tunnel with most of the requirements pertaining to larger wind-tunnel installations—a continuously variable range of air speeds; the air must pass the testing area with as little turbulence as possible; the air speed must be measurable with an accuracy better than that of the equipment to be calibrated therein.

To meet these objectives the unit illustrated on the front cover and in Fig. 1 has been built. The speed range is from 0.5 to 65 mph.; the driving power requirement is 5 hp. The tunnel is constructed from timber and 5/8-in. 5-ply plywood, although certain sections are formed from other materials. Over-all length is approximately 17 ft.; height is 11 ft. The width at the widest point is about 5 ft. Fig. 2 shows the operating throat of the tunnel, a section which is 34-in. long by 25-in. wide by 19½-in. high. One climate-survey-system anemometer is shown in testing position.

Instrumentation

Measuring instruments are on the bench panel adjacent to the tunnel. Wind speed is measured by three methods.

In the first method, a Beckman & Whitley "Model 170-A30" three-cup anemometer, calibrated by the U. S. Bureau of Standards, is inserted in the tunnel and its electric-pulse output is fed to a Beckman & Whitley "Model T3-11-6" pulse amplifier. The amplified pulses drive a Production Instrument Company "Model MDB-S4-6D" electric counter. This counter is operated in conjunction with a Standard Electric Time Company "Model S-10" electric timer—both instruments being operated through the same start-stop switch. By this method an accurate total count is obtained per unit of time.

In the second method, the same pulses from the anemometer are fed to a Hewlett-Packard "Model 500A" frequency meter, which provides an additional reading directly in pulses per second, permitting an instantaneous check on speed.

In the third method, a 12-in. Dwyer pitot tube is connected to a Dwyer transparent draft gage with a range of 0 to 0.50 inch of water. A 24-in. Dwyer pitot tube activates a Dwyer transparent draft gage with a range of 0 to 4.50 inches of water; this extra-long pitot tube permits sampling from any point in the test section.

Electric Drive

Circulation of air is accomplished by the six-bladed Aero-Vent fan. A 5-hp. 220-volt 3-phase motor drives through a Speed Selector variable-speed drive unit to the fan belt. Wind speeds above 500 feet per minute are controlled directly by adjustment of this variable-speed drive. Below 500 feet per minute the air speed is controlled through a baffle-plate mechanism located in the right hand vertical section of the tunnel. These rectangular aluminum baffle plates can be adjusted from full registration to complete blocking. In use, the plates are set to provide approximately the amount of air resistance estimated to be required, slid into place in the tunnel, and finally adjusted by wind-speed measurements made through the instrumentation set-up.

Air Flow

Air flowing from the fan passes vertical and horizontal straightening vanes which direct the air flow into the first set of turning vanes. Turning vanes are located at each of the four corners of the tunnel.

Turbulence in the tunnel is quieted by three 16-mesh bronze screens, two of which are located upstream from the test section and the third downstream. The screens are installed so that their tautness can be adjusted.

Electrically-operated valves will assume new importance in all-electronic computer-controlled control loops. Although now behind other operators in development, new design techniques can overcome present limitations. These techniques include pulsed engagement of solenoid valves and "over-volting" of motor drives. Circuits are presented for obtaining true servo response from conventional wound-rotor induction motors.

by A. BROTHMAN and S. LIDZ
Techniflex Corporation
New York

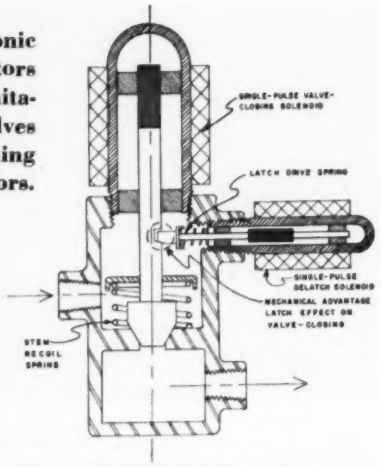


Fig. 1. Single-pulse-to-close solenoid valve, with pulse-delatch solenoid.

New design trends for

Electrically-operated Valves

ELECTRICALLY-OPERATED VALVES are valves powered by electrical power mechanisms. There are two types—solenoid valves and electric-motor-operated valves. Any critique of electrically-operated valves must be developed along two parallel lines of inquiry—(1) the suitability of electrically-originated power strokes to the operational demands of valves, and (2) the adaptability of electrical power mechanisms to the requirements of modern control techniques.

Electrically-operated valves have lagged behind in both categories of requirements. However, economical design excursions would produce superior control qualities, and would bring to electrical operators a range of applicability greater than that possessed by any other type of operator.

Solenoid Valves

In the field of on-off or two-position control, particularly where short valve strokes are demanded, solenoids offer a unique speed of response in comparison to other non-electrical power mechanisms. Moreover, packless solenoid valves eliminate valve-stuffing-box problems.

Present practice in manufacture of solenoid valves makes both direct and indirect use of solenoid power units. In direct application, solenoids are directly coupled to a valve stem. In indirect application, solenoids operate through mechanical-advantage or pneumatic-advantage mechanisms. Mechanical-advantage mechanisms are used frequently in solenoid valves for high-pressure applications. Pneumatic-advantage mechanisms use pilot orifices to control fluid pressure. Where advantage mechanisms are not used, it is frequent practice to employ soft composition seats or discs. This concession to directly used solenoids reveals the prevailing attitude of solenoid-valve designers about the feasible magnitude of solenoid power strokes.

Power Limitations

The question of what is a practical limit for solenoid-developed push or pull forces goes to the heart of any evaluation of solenoid valves. In most commercial solenoid valves (except manual-reset types) a single and sustained level of energization of a solenoid (obtained from a uniform source voltage) is used to stroke the valve and to hold off a spring-developed recoil action. Using a single level of energization and sustaining it for the entire engagement cycle of the solenoid imposes a limit to the solenoid force—a limit caused by the ability of the solenoid to dissipate the I^2R-developed heat.

Regardless of whether a-c. or d-c. solenoids are used, the magnitude of the power stroke is determined by the cross-sectional area of the plunger and by the square of the density of the solenoid-core field. The density of the core field depends on the square of the magnetomotive force (N^2I^2, where N is the number of solenoid coil turns and I is the solenoid current).

In d-c. solenoids, permissable coil currents and coil turns are limited by the possible resistances per unit volume of winding and by copper and winding costs. Further complicating the design is the sharp variation in the core field density over the length of the core.

In a-c. solenoids, the problem of increasing NI values becomes more complicated because increases in N result in higher coil inductances, which are inconsistant with increased coil currents. In addition, there must be added the heat due to hysteresis and short-circuiting eddy currents.

This says that larger plunger forces are not consistent with single and sustained levels of energization of solenoids. Larger plunger forces, and a consequent increase in the reliability of solenoid valves in all pressure ranges, must be approached through unconventional design practices.

Pulsed Engagement

In d-c. solenoids, simultaneous increases in N and I are made possible by combining high source voltages with self-locking or latch-in plunger actions which release the actuating coil from its power source. Fig. 1 shows one possible arrangement for circumventing the problem of dissipating heat. A pulsed-engagement action, which is delatched when the valve is thrown to its other position, is used. Pulsed engagement opens many possibilities for use of direct high surges from rectifier tubes of thryatron and

Presented at 2nd Annual Conference on Instrumentation in Water, Sewage and Industrial Waste Treatment, April 20, 1954, Manhattan College, N. Y.

ignitron construction, as well as from barrier-type rectifiers arranged in doubler and higher multiplying arrangements.

As regards a-c. solenoids, similar attack is possible. Here, larger magnetomotive forces, and consequent larger plunger forces, can be obtained by employing pulsed-engagement from step-up transformers. The higher source voltages would act to counter increased coil impedances. As concerns the cost of step-up transformers, the pulsed-engagement principle implicitly affords the opportunity to operate transformers under surge load, as well as to draw on high-voltage sinks which are charged intermittently.

The possibilities of the pulsed-engagement principle are not limited to a coupling with latch-in actions or to solenoids featuring enlarged magnetomotive forces. The techniques can be used also on valves with standard-size solenoids without benefit of an accompanying latch-in action. Where the solenoid acts thru a mechanical-advantage mechanism, or where a direct-acting solenoid must travel thru a stroke sufficiently long to exhibit a wide variation in plunger force, the possibilities of a pulse-type stroke initiation followed by a lower-voltage maintained energization appear attractive. A switching action permits maximum initiating forces and yet, by returning the coil to a lesser level of energization at an optimum moment, maintains coil engagement within normal heat-dissipation limits.

The required switching action need not be restricted to mechanical actions; the changing inductance of the coil during the stroke interval injects the opportunity to develop either an individual switching action or a smooth servo-developed continuous de-rating of the power source.

Mechanical-advantage Mechanisms

Another avenue for obtaining higher plunger forces is offered by use of more elegant mechanical-advantage mechanisms. The mechanisms now used are simple lever arrangements, limited to moderate multiplying ratios as a concession to the rugged ambient and corrosion conditions attending valve service. Today, plastic-to-metal bearing surfaces can yield excellent coefficients of friction without demanding rigorous clearance tolerances, dust seals, and special lubrication conditions; it behooves the solenoid-valve industry to investigate these in the interests of higher mechanical-advantage transmissions.

Summary on Solenoid Valves

Several advantages are placed within reach by methods of increasing power-stroke magnitudes, including increased reliability where infrequent energization is likely to develop cumulative "fouling" of the plunger path. Also, composition seats and discs of dubious long-term elastic properties may be replaced by more-durable metal disc-to-seat combinations. Finally, greater seal-off at higher pressures without the present restrictions as to valve size may be possible.

It was mentioned previously that solenoid power units are best adapted to short valve strokes. In on-off or two-position service, it often is possible to employ disc-and-seat combinations in which a short stroke provides for a comfortable multiple of the full port area of the valve. However, where two-position control must be reconciled with strokes of such length that a wide variation in plunger force would be involved, two-position, snap-acting motorized valves are more suitable.

Electric-motor-operated Valves

There are two categories of drives for electric-motor-operated valves—(1) drives featuring single direction of rotation for the motor, and (2) drives employing bidirectional rotation. Electric-motor-operated valves are also divisible into (1) snap-acting 2-position valves, (2) snap-action multiposition valves, (3) push-button-control full-range throttle valves, (4) valves responding in modulating fashion to low-level instruments of the Wheatstone and impedance-bridge type, and (5) valves responding to instruments on the servo-level.

Single-direction motor drives are used to power simple rotary-motion discs such as plug, cock, and certain types of spherical-disc valves, and also to power reciprocation-motion discs. Such drives are employed to power valves in 2-position snap-acting duty. Reciprocating-motion discs are limited to smaller sizes of discs as well as to relatively small stem strokes; valves of the globe type generally are used.

Most single-directional motor drives employ some variant of the cam-and-cam-follower principle in translating the motor's power stroke into a stem stroke. However, direct application of the motor's power may be used, sometimes through a gear train.

Single-directional motor drives are perhaps the most highly developed. For two-position snap-acting duty, and where strokes of moderate lengths and comparatively low seating forces are required, this type is satisfactory. Both from the standpoints of available seating forces and possible stroke lengths, this type of powered valve is generally superior to solenoid valves. Their dependability is also greater. However, when attempts are made to use this type of motorized valve in modulating control, less than satisfactory service is frequently obtained—particularly when the stem travel is not a linear function of the motor's motion. In such instances there is a shifting throughout the length of the stroke in the accuracy with which the valve can be positioned. Also, few of these drives are designed for fast stopping. Accordingly, there is the tendency of the power stroke to overdrift the cessation of the travel signal.

Bidirectional Motor Drives

Bidirectional motor drives are generally applied to valves involving large stem forces and long strokes. They are used with both rotary and reciprocating-motion discs. Although some use of bidirectional drives is made in snap-acting two-position service, by far the largest application is in (1) selector-switch-directed multiposition service, (2) push-button full-range modulating services, and (3) instrument-responsive full-range modulating service.

In most applications, the motor drives the valve through a standard gear transmission, usually worm gear, although such drives are not efficient. However, they are used because of the ease with which impact-load-relief devices can be incorporated within such transmissions. These impact loads are associated with driving into the full-open and full-closed positions.

In the rare instances in which bidirectional motor drives are applied to snap-acting two-position-service valves, stem speeds as high as 180 inches per minute are used. In some instances of selector-switch multiposition service, stem speeds of 60 inches per minute are common. However, for modulating control, regardless of whether the modulation is push-button directed or instrument directed, stem speeds decline to about 6 to 20 inches per minute.

Present Status

To summarize the present state of development of bidirectional motor drives: (1) such drives involve a linear relationship between stem stroke and motor's rotation, (2) they vary widely in stem speed, (3) they incorporate impact-load-relief devices to protect the drive against the full-closed and full-open positions of the valve, and (4) the drives are consistent with long stem strokes, high stem forces, and almost any type of disc-and-seat arrangement.

This type of valve operator needs much modernizing. The power demanded is frequently excessive. The impact

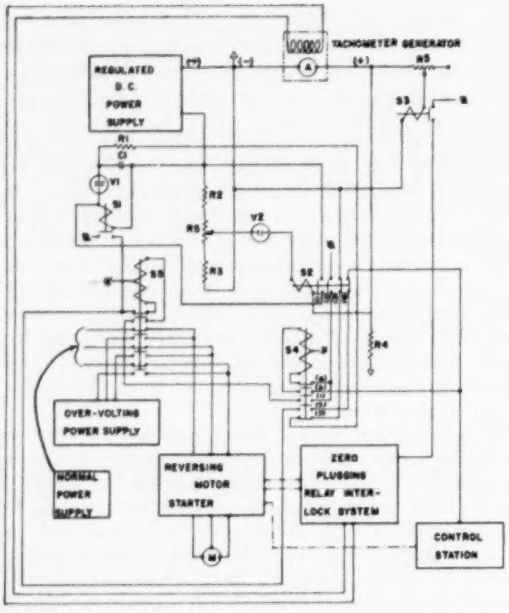


Fig. 2. Circuit for over-volting and accurately stopping a squirrel-cage induction-motor valve drive.

load devices are cumbersome and lacking in precision adjustability. In modulating duty, the stem speeds are slow compared to pneumatically and hydraulically operated valves; also, there are inadequate accommodations to accurate stopping and to meeting peak starting loads.

Improvements Required

Any valve operator must meet the demands of the valve itself, and of the control technique or instrument system.

The operational power demand of the valve requires study of the stem force requirements versus valve position; the power demand is a function of the stem's speed and the instantaneous stem force requirement.

Functional demands imposed on operators by the control technique raises the topics of stem speeds, whether or not uniform stem speeds can be employed, and accuracy of stopping. For all services to which bidirectional valve drives are applicable, stroke speeds must duplicate the speed characteristics of pneumatic-top power machines.

All conventional available bidirectional motor drives provide solely for uniform stem speeds. For many applications, uniform stem speeds are satisfactory. However, in operators responsive to instruments on the true servo level, it becomes necessary to approximate the varying speed-of-approach which is inherent in pneumatic operators. Without such effect, much of the benefit of the feedback signal in true servos is nullified.

For accurate stopping, the drive must incorporate means for minimizing inertia overdrift.

When varying stem loads are coupled with higher stem speeds, a sharp variation in running, starting, and stopping power demands follows. Moreover, the impact-load-relief devices are likely to be more heavily taxed. Where the operator must enforce a declining speed as the powered valve approaches the position demanded by a servo instrument, varying stem-force requirements mean that the motor must be instantaneously responsive both to the declining error signal and to the valve's stem-force requirements.

To meet the problem of widely-shifting starting and running loads, the present practice of selecting a motor size that is equal to the valve's most imposing demand is devoid of engineering elegance and shortens the motor's life. Similarly, the practice of using worm-and-wormwheel transmissions aggravates this problem (any type of gearing involving a transverse sliding of the surfaces of the meshing teeth is a low-efficiency transmission, and the efficiency of such gearing under starting conditions can be as low as ¼ of its running efficiency). As regards stopping accuracy, it is impossible to go along with the present convention of relying upon simple de-energization of the motor with the instantaneous stem load and the transmission friction limiting the inertial overdrift.

Use of Over-volting Supply

When a-c. power is used, the problems of varying power demand on starting, running, and stopping can be met by the arrangement in Fig. 2. Here it is assumed that a valve subject to a widely varying stem force is driven by a "Design-D-type" squirrel-cage induction motor. Such a motor has a starting torque of 275 percent of its full-load torque; it is the type best suited to widely varying running and starting loads. Its locked-rotor torque is about 300 percent of its full-load torque, and hence it can accommodate temporary overloading.

As the torque of all squirrel-cage induction motors varies as the square of the applied voltage, the motor can be adapted to stringent demands by "over-volting." As shown in Fig. 2, two power supplies are provided—one of normal voltage, and one at a higher voltage (from a high-voltage plant supply or from a 3-phase step-up transformer).

The circuit in Fig. 2 provides for automatic engagement of the over-volting supply, and for accurate stopping of the drive. The motor drives the transmission and a tachometer-generator. For energizing the over-volting supply on starting loads, the tachometer acts in concert with a "critical-speed" sensing unit and coordinated R-C timer. The critical speed is that speed at which the motor begins to overload; to sense this speed, a regulated d-c. supply is connected in series with the tachometer. The tachometer has to attain a given speed before neon tube V2 ignites and engages relay S2. Under starting conditions, this relay cancels the timing scheme—that is, it disengages mechanically-held relay S4. Because of this, the R1-C1 timing combination is connected to the high side of the regulated d-c. supply (via #3 n.c. contacts in S2 and the #3 n.c. contacts in S4). Capacitor C1 then charges. The time for it to charge to the ignition value of neon tube V1 defines a time interval in which the "critical speed" should normally be reached. If S1 engages before S2 does, it signifies an overloading of the motor at its normal excitation voltage, and delivers an engagement signal to the power relay (S5) whereby the motor is placed under over-volting excitation. Thereafter, whenever the motor reaches its "critical speed," S2 engages and by its n.o. #2 set delivers an engagement signal to S4 and a succeeding disengagement signal to S5 across the n.o. #1 contacts in S4 to return the motor to its normal excitation supply. On the other hand, if S2's engagement precedes S1's, the timing cycle is cancelled.

The overvolting arrangement is energized also when a peak load begins to stall the motor.

Finally, for accurate stopping of the valve, the tachometer also operates relay S3 thru variable-resistance R5, which fixes the speed at which S3 disengages as the motor speed declines. Thus, if provisions are made via a relay interlock system for the plugging of the motor, relay S3 and the tachometer signal the conclusion of the plugging cycle. Plugging, under the direction of S3's zero-speed signalling, becomes a powerful and dependable way of braking the motor for accurate stopping.

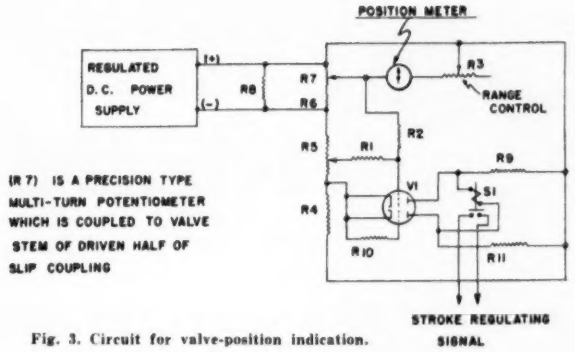


Fig. 3. Circuit for valve-position indication.

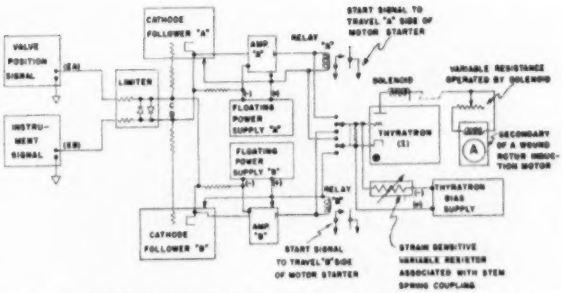


Fig. 4. Circuit for control of valve-stem speed in response to error signal and stem loading force.

Where the stem-force vs. stem-stroke curve does not show a sufficient variation to warrant overloading as a technique, or where a "Design-D" squirrel-cage induction motor is sufficient for the load variation, it is possible to use zero-plugging alone. This should be done for accurate stopping. Also, where the drive's flywheel inertia plus the motor's locked torque characteristic is sufficient for peak loads encountered during a running cycle, the scheme in Fig. 2 should be narrowed to the provisions for overvolting on starting alone and for plugging. Finally, where d-c. motors are used, it is possible to use the basic principles even where the starting of the motor involves a sequential manipulation of the field or armature excitations.

Impact-Load Relief

Improved impact-loading relief devices also are needed. Where stem motion is reciprocating, we recommend use of a spring cushion in protecting against the full-closed position. This coupling is directly responsive to the stem's loading, and cannot reflect inefficiencies in the drive, as do present cushion devices.

For rotary-motion stems, we urge use of adjustable slip couplings which are as purely responsive to the stem's loading as is possible.

In both reciprocating-motion and rotary-motion stems, our recommendation is that the impact-relief device be associated with the position-indication means (Fig. 3).

Here, a precision multiturn potentiometer (R7), driven by the stem or by the driven half of a slip coupling, applies a position-sensitive potential to a microammeter. The maximum needle swing is made to correspond to the valve's full stroke. The grid voltage on one side of the double-triode tube depends on the valve's position. Therefore, relay S1 remains engaged until the difference in the two plate voltages drops beneath the dropout voltage rating of the relay. The position of the stem that causes the disengagement of S1 is adjustable via potentiometer R5. With this disengagement action, we recommend the signalling-in of a zero-plugging action for sharply defining the valve stroke.

Stem Speed Control

The final problem is that of enforcing a declining stem speed as the valve approaches rebalance. This is not a simple matter of speed regulation in response to a declining error voltage; it is also necessary to adjust the output torque of the motor. These requirements lie within the capabilities of (1) a-c. polyphase motors in which the phase windings are susceptible of multi-source excitation (the whole class of a-c. servo motors), (2) a-c. wound-rotor induction motors, and (3) any d-c. motors with good load-vs.-speed regulation characteristics. As power demands exceed the ratings of servo-motors, use of the latter two types of motors is indicated, but in such a manner that the performance characteristics of servo-motors are approximated. Such a scheme is shown in Fig. 4.

The basic elements are (1) a wound-rotor induction motor which is adapted to varying output torque and speed via a manipulation of a resistance in the motor's secondary, (2) a strain-gage element, and (3) a comparison or balancing circuit which provides the automatic manipulation of the resistance in the motor's secondary.

The balancing circuit includes a dual floating differential amplifier into which the valve-position signal (E_a) and the instrument signal (E_b) are fed. The difference signal (E_a–E_b) is limited and then fed to two separate and parallel cathode-follower coupling stages.

Whether relay A or relay B is operated depends on the polarity of the error signal. These relays control the motor direction. As the plate of the thyratron is subject to a-c. excitation, the conducting period depends on the magnitude of E_a–E_b.

A resistance-type strain-gage element associated with the stem spring cushion controls the bias of thyratron I. The strain element is of the carbon-pile type; an increasing stem loading produces a declining resistance. This increases the bias as the stem becomes more heavily loaded. Thus an increasing stem loading produces a more negative biasing of the thyratron, while a declining error voltage drive's the grid more positive. Thus the current in the solenoid (which controls a variable resistance in the motor's secondary) would at all times reflect the balance between the two factors to which the motor should be subject. An increasing resistance in the motor's secondary tends to reduce the full-load speed in response to a declining value of (E_a–E_b); a decreasing of the resistance in answer to an increasing stem loading tends to increase the motor's output torque at any given speed.

Whenever either relay A or relay B is engaged, the appropriate direction of rotation is held until the error is "nulled out." Their disengagement becomes the signal for a zero-plugging action on the motor to assure accurate stopping. The scheme, although outlined for a wound-rotor induction motor, can exert similar load and speed regulation over a Ward-Leonard variable-speed system or any suitable d-c. motor.

The Future

The recommendations expressed are abstracted from a research and development program that has been in progress for four years. Electrically-operated valves embodying these suggestions have been developed and are scheduled for commercial production. The guiding perspective has been faith in the future of electronic controllers, and a belief that the next major line of development for the process industries will be the installation of automation via over-all computer control. The fundamental nature of electronic controller and computer input and output signals will raise electrically-operated valves to a new importance.

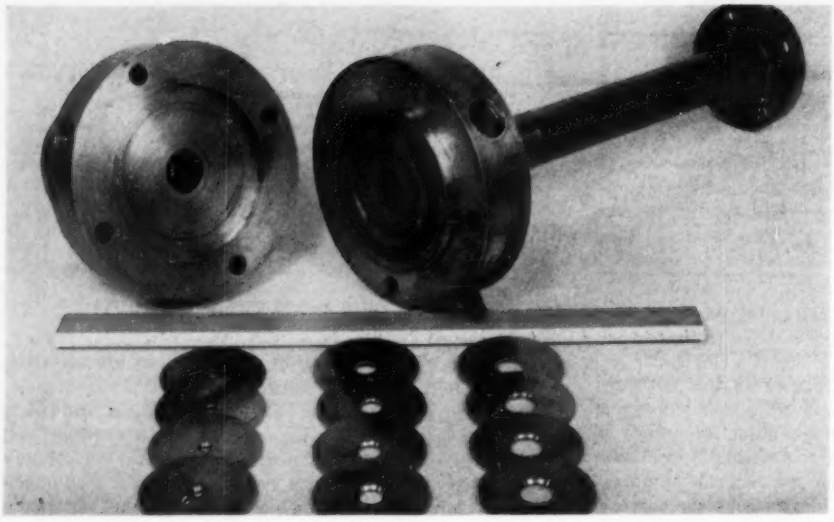


Fig. 1. Meter tube and small orifice plates used for tests on edge sharpness and edge thickness. (Results of latter tests will be reported in near future.)

by G. C. HUFFMAN[1], L. W. THRASHER[2], and R. C. BINDER[3]

Importance of Edge Sharpness on

THERE is a lack of published data on small flowmeters, including orifice, flow-nozzle, Venturi, area, and other types in sizes 2-inch and under. Preliminary studies indicate that the small sizes involve complications not found in the large sizes; tolerances, edge conditions, surface finish, and hole dimensions become more critical as the size becomes smaller. The following presents the results of a study of orifice meters.

Description of Apparatus

Fig. 2 shows the meter arrangement selected to conform with many suggestions received from a survey of workers in the field of fluid meters. The apparatus included a ¾-inch meter tube and orifice plates, piping from water source to drain, weighing and timing equipment for determining weight rate of flow, pressure gages and manometers for determining pressure drop, and temperature-measuring equipment.

The orifice tube was made of bronze pipe. As illustrated in Fig. 3, the upstream section of the orifice tube was made 15 pipe diameters in length, and the downstream section was made 5 pipe diameters in length (internal pipe diameters). The orifice tube was connected to standard ¾-inch galvanized steel pipe by means of flanges that were constructed to allow the ends of the pipe and tube to butt together and thus minimize upstream and downstream disturbances. The total undisturbed straight length upstream from the orifice was 50 pipe diameters—that is, from the upstream thermocouple to the upstream face of the orifice plate.

There was metal-to-metal contact between the brass flanges and the orifice plate. Radius pressure taps, ¼ inch in diameter, were used. The center of the upstream hole was one pipe diameter (actual) from the upstream side of the orifice plate. The center of the downstream hole was one-half pipe diameter (actual) from the upstream side of the orifice plate. O-rings were used as seals. An air bleed was provided in the vertical plane of the orifice tube in the upstream flange.

Each orifice plate tested was made of 18-8 stainless steel and was 0.060-inch thick. The orifice hole in the plate was drilled to the approximate size and then bored to the final diameter. The downstream section of the orifice plate was beveled 45 degrees to the orifice axis, leaving a 0.010-inch cylindrical ledge downstream of the sharp edge.

The orifice plate was located in a recess in the upstream flange to reduce eccentricity of orifice and pipe. Maximum eccentricity was 0.006 inch.

The difference between room temperature and water temperature was 20 ± 5 degrees F. throughout the tests.

Notation

The discharge coefficient C is defined:

$$Q = CA(2\Delta p/\rho)^{1/2}(1-\beta^4)^{-1/2}$$

where Q is volume rate of flow, A is orifice area, ρ is density of fluid, β is ratio of orifice diameter to pipe diameter, Δp is pressure differential across orifice.

The pipe Reynolds number N is defined:

$$N = \rho VD/\mu$$

where V is average velocity in pipe, μ is dynamic viscosity of fluid, and D is pipe diameter.

Test Results

Tests were made of a series of orifice plates (called Series A) with beta ratios of 0.2, 0.4, 0.5, 0.55, 0.6, 0.7, and 0.8. Care was taken to make sure that the upstream corner of each orifice plate was square and sharp, and free from either burrs or rounding, so that when viewed without magnification a beam of light was not reflected by the corner. The upstream face of each plate was hand polished.

[1]Planning and Methods Department, Goodyear Tire and Rubber Co., Akron, Ohio.
[2]Research Fellow, Purdue University, West Lafayette, Indiana.
[3]Professor of Mechanical Engineering, Purdue University, West Lafayette, Indiana.

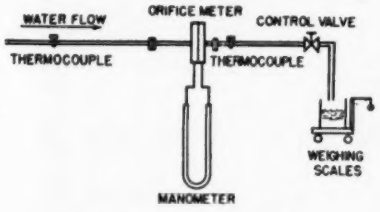


Fig. 2. Arrangement of apparatus.

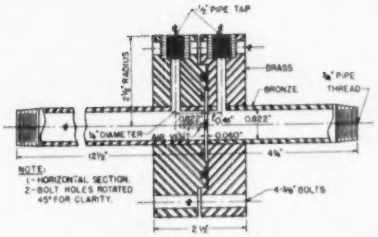


Fig. 3. Orifice meter.

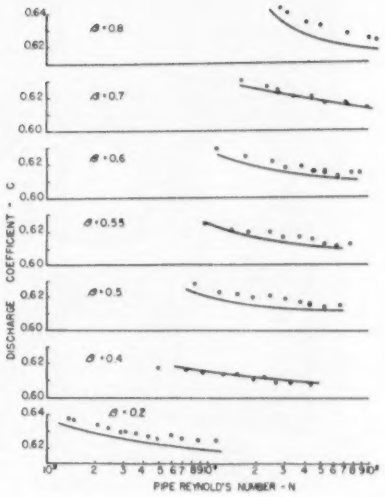


Fig. 4. Comparison of Series-A and Series-B test results.

Discharge coefficients, plotted as a function of pipe Reynolds number, show that small differences in edge sharpness affect the discharge coefficient of a small orifice meter. There is need for simple, practical means for measuring, specifying, and reproducing edge sharpness; the accepted light test without magnification is not sufficient.

SMALL ORIFICE METERS

Effect of Edge Sharpness

In order to check reproducibility, another series of orifice plates, identical to Series A, were made and tested. This duplicate set is called Series B.

The solid lines in Fig. 4 are the curves of discharge coefficient vs. N for Series A plates. The points in Fig. 4 are for the Series B plates. In general, the Series B points are higher than the Series A curves. The discrepancy is due to edge sharpness. This brings up the difficult problem of devising simple, practical means for measuring, specifying, and reproducing edge sharpness.

Each of the Series A and the Series B plates met the light test without magnification. Plates were photographed under a vertical light source at magnifications of 6 to 10 times. With magnification, the Series A plates showed a sharp corner (a beam of light was not reflected by the corner); the Series B plates showed some spots of reflected light and thus indicated that the edge was not sharp.

Several methods of characterizing the edge sharpness were tried. In one it was assumed that if the orifice was used to form a horizontal free jet of water, irregularities of the edge or eccentricity of the hole might cause distortions of the jet or deviation from a vertical plane. When the jet was compared with the vertical hairline of a cathetometer, no measurable distortion or deviation from the vertical could be observed for any of the orifices.

With a sulphur-graphite compound, molds of the edge were made. Some measure of sharpness might be established if these molds could be compared with some standard edge in an optical comparator. The orifice edge could not be represented accurately by these molds because of shrinkage of the compound and chips resulting when the mold was removed from the orifice plate. Of those tried, the only successful method was an examination of each orifice plate under a magnification of about thirty diameters.

Effect of Pressure-tap Diameter

A second orifice tube having ⅛-inch-diameter pressure taps was made, and all plates of both series were tested in it. The results were nearly identical with the data from the tube with ¼-inch-diameter taps.

As these two tubes were tested at different times, the agreement of the data is a further indication that the discrepancy between supposedly duplicate plates is due to a difference in edge sharpness.

Accuracy

The deviation of the data from the mean curves shown in Fig. 4 is less than one-third of one percent for all orifices. The uncertainty of the data is believed to be 0.4 percent.

Conclusion

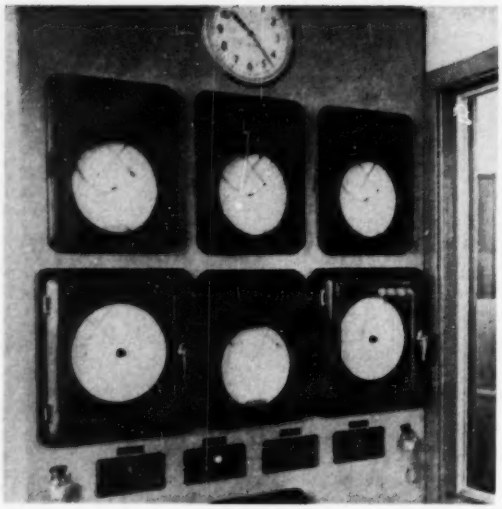
Very small differences in edge sharpness can affect the discharge coefficient of a small orifice meter. An accepted test for edge sharpness of an orifice is that the edge shall not appear to reflect a beam of light when viewed without magnification[1]. For the orifices investigated, this test was not sufficient. There is need for simple, practical means for measuring, specifying, and reproducing edge sharpness.

Acknowledgement

The authors are grateful to Dean A. A. Potter and Professor H. L. Solberg, of Purdue University, for making available the facilities for these tests. Some material in this paper was adapted from a Ph.D. thesis[2].

Bibliography

1. "Fluid Meters, Their Theory and Application," ASME Report, New York, 1937, Par. 178.
2. "Investigation of Small Orifice Meters," by G. C. Huffman, Ph.D. thesis, Purdue University, February, 1953.



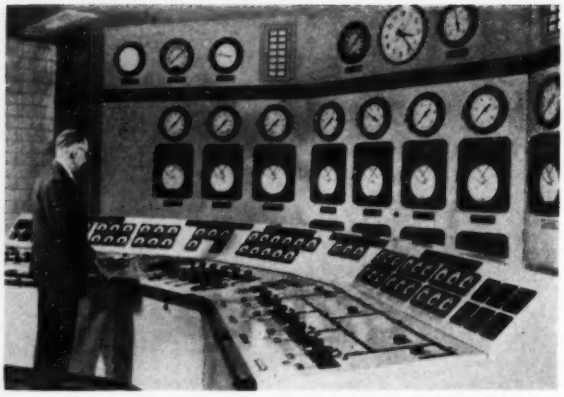


Fig. 1. (left). Pumping-room panel of town of Dartmouth, Nova Scotia.

Fig. 2. (above). Tennyson Station, Cincinnati.

Water Treatment Requires

Centralized control is highly developed in water treatment, including extensive use of telemetering. Cabled tubing and miniature instruments are important in centralized installations. Trends are shown.

by R. S. DARKE
Bailey Meter Company

CENTRALIZED INSTRUMENTATION and control are synonomous with progress in almost every process industry today. "Water" is a process industry—one of the largest and most important.

The development of centralized operation in water plants has exceeded that in some other process industries, due in part to the large areas and distances involved in treatment plants and in distribution and pumping systems. The need for centralization—collecting operating information at a central point—is obvious.

Typical of centralization in a moderately sized plant is the pumping room at Dartmouth, Nova Scotia (Fig. 1). Under the supervision of one man, this is a pumping station with flow and level measurements transmitted to the operating location; the metering equipment also establishes control for the lime feeder and automatic chlorinator.

For the large pumping station and distribution plant, the Tennyson Station of the City of Cincinnati utilizes some of the latest concepts of centralized instrumentation (Fig. 2). The console is arranged for convenient operation of the entire system. The vertical panel behind the console provides the basic instrumentation—the recorders provide the history and trend of operations.

Telemetering

Telemetering is the heart of any centralized instrumentation and control system, regardless of the type of plant or method of transmission involved—mechanical, electrical, electronic, or pneumatic.

Mechanical transmission systems include direct-connected meters plus cables or linkage to transfer pen or pointer motion to a different location. A pertinent example is the earlier type of rate and head-loss gages in use in many filter plants.

Electrical systems of telemetering using voltage-balance (potentiometric) principles are adequate for distances of miles, depending on the type of transmission lines and transmitters used. Electrical systems of the *time-impulse type* permit telemetering for 1,000 miles or more. However, these systems do not provide instantaneous and continuous action, as do the voltage-balance (potentiometric) type.

Pneumatic telemetering is generally satisfactory up to 1,000 feet. Systems of this type are continuous, without step action. Transmission lag, normally inconsequential

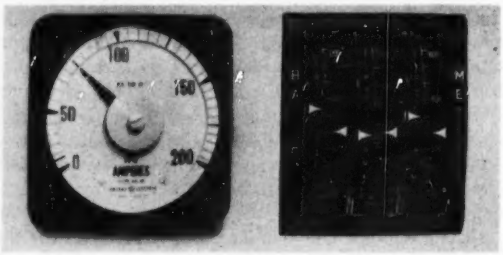
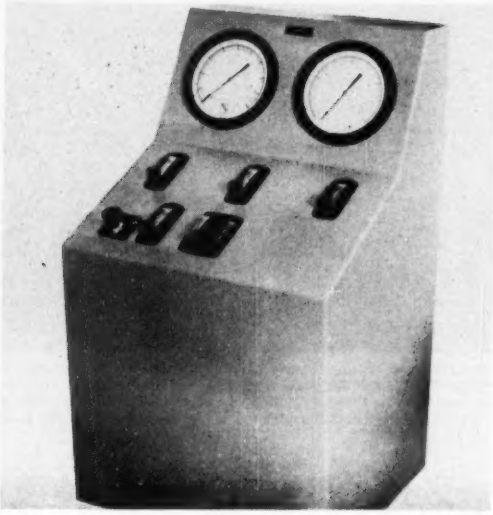


Fig. 3. Comparison of a group of miniature vertical-scale indicators with a standard 4½-inch switchboard ammeter.

Presented at 2nd Annual Conference on Instrumention in Water, Sewage and Industrial Waste Treatment April 20, 1954, Manhattan College, N. Y.



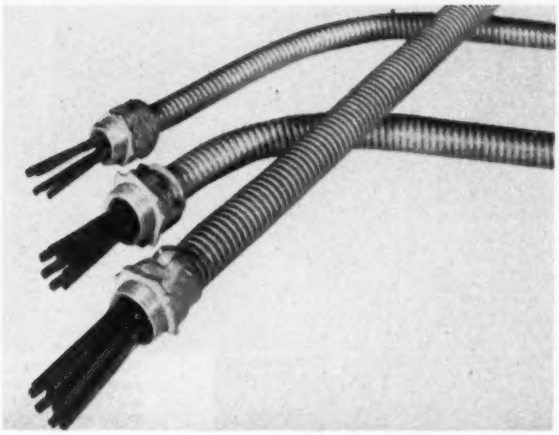


Fig. 4 (left). Filter operating table with pneumatic control system.

Fig. 5. (above). "Armortube" bundled pneumatic lines.

Centralized Instrumentation

for straight metering applications, may have to be considered when tied in with control.

The trend in water-treatment and filtration plants is toward use of pneumatically-operated metering and control equipment. Available from many manufacturers, pneumatic transmission is flexible, safe, and simple.

Centralization Problems

In a large plant, a centralized control room can become unreasonably large. Also, the number of connecting lines poses a serious installation problem.

Much of the information gathered by intruments on continuous processes is of little use except during periods of disturbance. Therefore, in reducing the size of control rooms and operating positions, it is possible to use monitoring or scanning techniques to automatically scan a number of factors from one point with one instrument. A combination of telemetering principles used in monitoring a number of variables from a central operating position is used on an oil-company pipe line which runs across Illinois, Indiana, and Ohio. The operation of four pumping stations on the line are controlled entirely from the central dispatch center in New York City, and involves scanning of various factors using voltage-balance transmission locally, and automatic Teletype techniques for long-distance transmission.

Miniature Equipment

Development of miniature equipment nas reduced space requirements of central operating positions. Miniature, vertical-scale Bourdon-tube-actuated indicators, approximately 4¾ inches high, can be nested together in groups (Fig. 3). They are available with two pointers per scale, each pointer actuated by a separate tube.

Miniature manual-automatic selector valves and remote manual-control units provide multiple functions in a single unit of small size. Illustrating a new approach to the filter operating table is a console-type unit incorporating a completely pneumatic system with miniature components plus conventional indicators (Fig. 4).

Installation

Installation of pneumatic equipment requires use of many lines for transmission of air pressure. To facilitate installation of centralized instrumentation, there has been developed a cabled bundle of copper or aluminum tubes called "Armortube" (Fig. 5). It consists of four, eight, or twelve ¼-inch-O.D. copper or aluminum tubing lines wrapped with a steel armor. The tubes are cabled with slight spiral to facilitate bending the cable without shortening any one line more than the others. One line in each circular group is traced for identification. It is available in nominal 500-foot random lengths; the potentialities of "Armortube" for installing pneumatic lines are obvious. Neat in appearance, it is self-supporting over considerable distance when compared with individual copper or aluminum tubing lines. Also, the steel armor protects the tubing lines during all phases of construction and during normal operation.

Conclusion

Generally speaking, the development of centralized instrumentation is a step toward making it possible to operate a plant more efficiently. Water treatment, pumping, and filtration plants have always had some degree of centralization, but with the development of new equipment in all process fields, a greater degree of centralization is possible. Both electrical and pneumatic means of telemetering information and control impulses are and can be used. Needless to say, there will be a continued trend towards more and more centralization of operation as each plant and industry takes a step—full or partial—toward completely automatic operation.

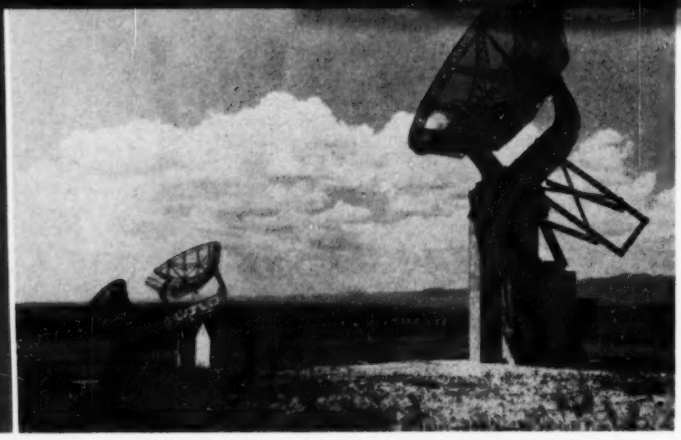
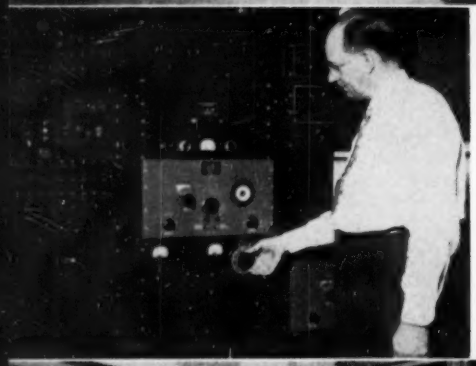


Fig. 1: World-wide network of observatories supply CRPL with solar-activity data. Fig. 2 (upper right): Gun Barrel Hill, Colo., NBS field station contains three giant Wurtsburg antennas that automatically track the sun. Fig. 3 (left): NBS primary resonator frequency-standard, based on 100-kc. crystals. The accuracy of this system is more constant than the rotation of the earth.



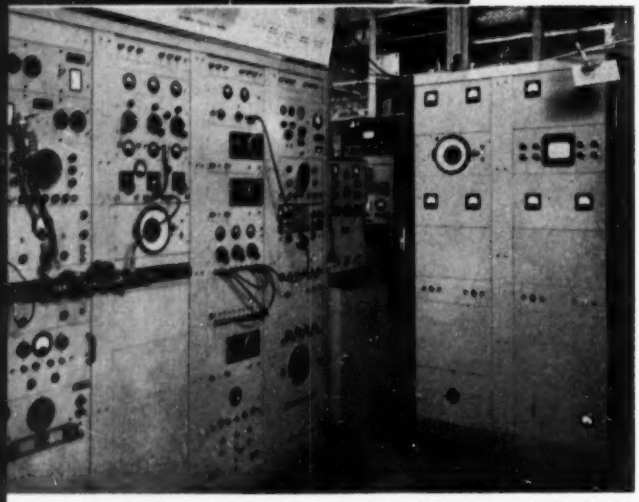


Fig. 4 (above): NBS microwave adjustable frequency standard with which secondary frequency standards are calibrated for government agencies and industry. Dolly-mounted racks at right contain Model II ammonia clock.

Fig. 5 (below): Interior of NBS radio station WWV, Beltsville, Md.

NBS RESEARCH IN

INCREASED utilization of the space available in the radio spectrum by almost every phase of industry, commerce, science, and the armed services has been the determining factor in formulating the program of the Central Radio Propagation Laboratory (CRPL) of the National Bureau of Standards.

As the Nation's central agency for collecting radio propagation data, CRPL in turn analyzes and disseminates information that aids reliable global aviation, all-weather shipping and harbor control, and worldwide communications. Regular ionospheric predictions are issued in the monthly publication "Basic Radio Propagation Predictions," CRPL Series D. A disturbance warning service also forecasts ionospheric storms.

Current activities are divided along research lines essentially according to the manner in which radio energy is propagated. Responsibility for pursuing the program is assigned to three laboratories and a service section. The *Ionosphere Research Laboratory* investigates the physical phenomena affecting the ionosphere and radio propagation in and through the ionosphere (50 to 300 miles above the earth's surface). The *Systems Research Laboratory* is concerned with the characteristics of radio systems depending on propagation in the troposphere (up to about 10 miles above the surface of the earth). The *Measurement Standards Laboratory* performs research and develops standards and methods of measurement for all electrical quantities used at radio frequencies. Finally, the CRPL *propagation prediction services* correlate the wide-spread observations made by CRPL and other laboratories (both foreign and domestic) and prepare propagation predictions.

Measurement Standards Laboratory

The Central Radio Propagation Laboratory is responsible for the maintenance and development of electrical standards and standards of measurement in the frequency range between 30 kc. and 100,000 Mc. The NBS standard of frequency is composed of a series of quartz-crystal oscillators, each of which vibrates at an extremely constant rate of 100,000 cycles per second. The reference vibrations are electrically multiplied and divided to produce a whole series of standard frequency signals ranging from a few cycles up to 100,000 megacycles. This range makes it pos-

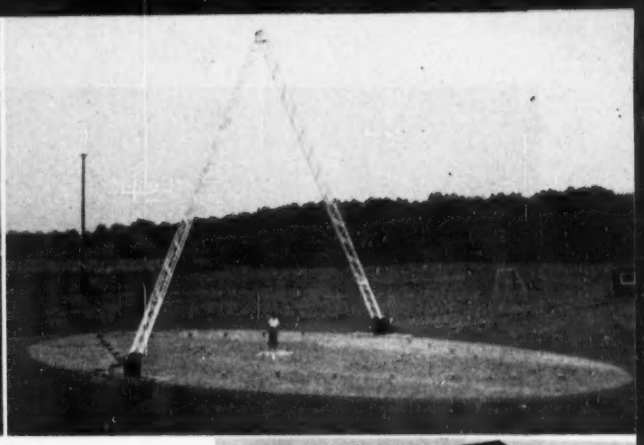
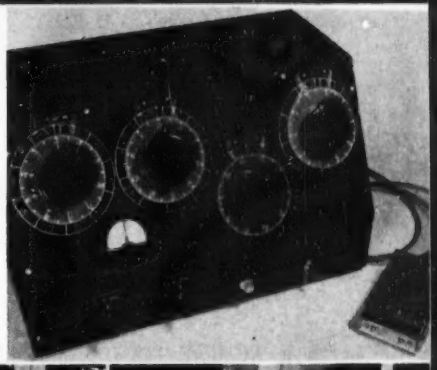


Fig. 6: Interior of NBS station WWV. Fig. 7 (upper right): NBS model antenna range, the largest of its kind designed to measure antenna radiation patterns in the vertical plane; inverted-V structure has target transmitter at apex, and can move in 180-deg. arc. Fig. 8 (right): Analog computer for solving the radio-refractive-index equation automatically from observed meteorological parameters—temperature, atmospheric pressure, and relative humidity.



RADIO PROPAGATION

sible to conduct precise research and development programs in radio-frequency standards. These standards are incorporated into the measurement of quantities such as dielectric constant and power factor, impedance, power, field strength, attenuation, voltage, magnetic permeability, and current. In addition to the "laboratory" standards, CRPL broadcasts standard carrier frequencies (2.5, 5, 10, 15, 20, and 25 Mc.) from WWV, and three from station WWVH (5, 10, and 15 Mc.).

Standard methods of measuring dielectric constant and power factor of solids, liquids, and gases have been established by CRPL over a wide range of radio frequencies. Many instruments and comparison standards have been and are being developed for measuring specimens. A program for the improvement and automation of dielectric measurements has led to the development of refractometers for observing the refractive index of the atmosphere, and has contributed to the study of the propagation of microwaves. Related studies have included investigations of transmission-line characteristics, gas measurement, high-Q circuits (reentrant cavities), and the calibration of capacitors, inductors, and special radio components. Impedance standards of all magnitudes currently used are being developed.

Standard techniques are available for measuring power between 10 kc. and 300 Mc. and within the power range between a microwatt and a megawatt, depending on frequency and waveform. Present measuring equipment is capable of handling mostly c-w. (continuous-wave) power. The equipment will eventually handle pulsed power (c-w. modulated and pulse modulated). Throughout the frequency range, investigations are in progress on absolute and independent methods of power measurements using devices such as bolometers, thermistors, and calorimeters for cross-checking absolute accuracy.

Lack of authentic comparative information on the characteristics of powdered iron and other magnetic materials was responsible for a research program aimed at the development of instruments and methods to measure accurately permeability and loss factor. The resulting instrument is known as an r-f. permeameter and serves as a secondary standard. It is now possible to establish specifications for powdered iron based on the accurate results of NBS instruments and standards.

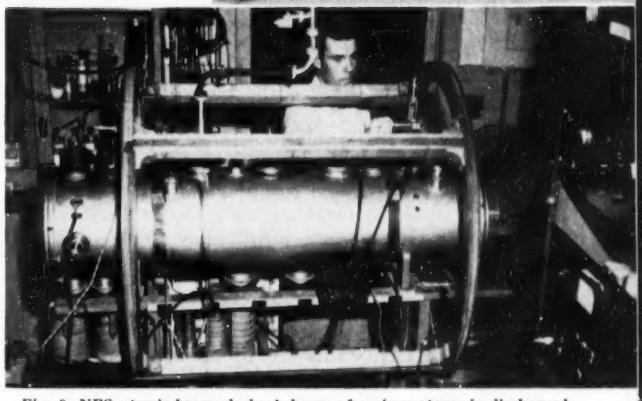


Fig. 9. NBS atomic-beam clock. A beam of cesium atoms is discharged and moves down the cylinder from left to right. When the atoms pass through an electromagnetic field, they vary from a straight-line path. This variation produces the correct frequency. Accuracies better than one part in 10 billion can be obtained.

Fig. 10 (below): The NBS microwave refractometer employed near Boulder, Colorado for measuring the refractive index of the lower atmosphere. During measurement, this unit is raised to the top of a 500-foot tower.

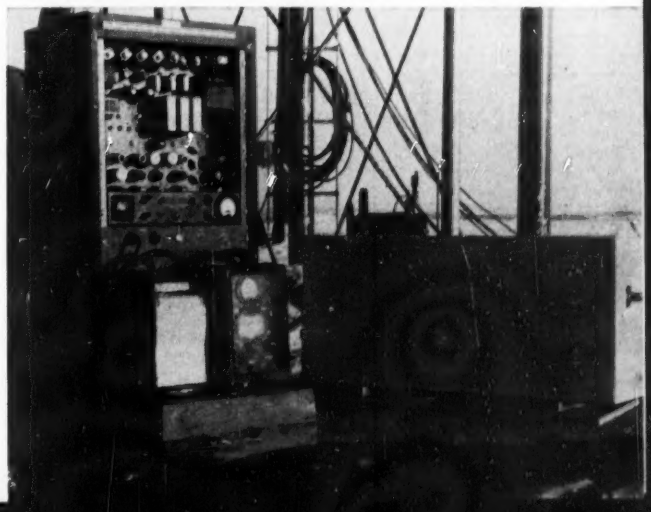


Fig. 1. Recording load meter used to analyze machine-tool operation.

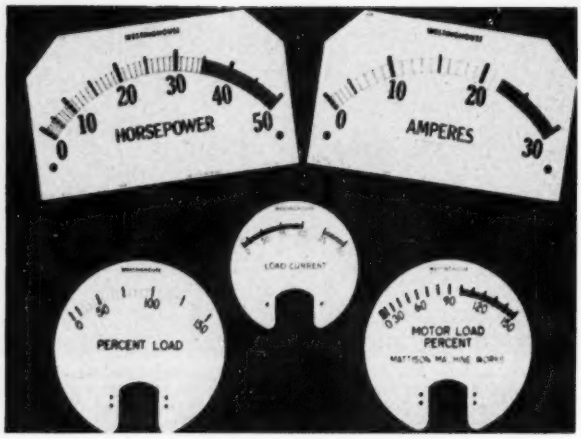


Fig. 2. Various dials now in use.

Machine-tool Load Indicators

MACHINE TOOL comprises three basic elements—a power source, an intermediate element, and a tool. Theoretically, the load on the machine can be measured in terms of any of these elements. However, measurements on the tool are difficult, particularly in operation. The same is true for the intermediate element; measurements of rate of feed, length of travel, or depth of cut do not directly indicate the load. Thus the power source, or motor, turns out to be the most desirable element for study of machine-tool load, for several reasons.

Three objectives are possible by load measurement. These are control, protection, and analysis.

Control

Control is exercised by varying and adjusting the load on the equipment. This can be accomplished by varying the depth of cut, rate of feed, and speed. The operator is guided either by observation of the tool and work, by "feel" or intuition, or by observation of an indicator. Because of its speed of response, and because it gives a direct measure of load, an electrical measuring instrument is the most satisfactory guide for operator load control.

In operations where all other variables are fixed, such as automatic lathes or boring mills, the indication of the instrument will indirectly warn of increasing dulling of the tool because the load will increase as the tool loses its edge.

Protection

Protection is commonly accomplished by fuses, breakers, and other protective devices, but an indicating instrument will warn of overloads before the automatic devices operate, thus maintaining continuous operation.

Analysis

Analysis may be accomplished by periodic reading of an indicator or, more conveniently, by recording instruments (Fig. 1). A continuous chart of current or power will show down time, percent utilization, amount and duration of overloads, and give a picture of the complete machine cycle.

The input load to the motor is (1) the total load on the machine tool, (2) proportional to the load on all components, and (3) the most logical and convenient point to make load measurements. Measurements can be made in terms of either input current or power. Experience has shown that satisfactory results are obtained by measuring current.

By combining and comparing charts for different machines taken at the same time, demand peaks may be isolated. Proper spacing of these peaks will reduce total demand and avoid penalty power charges.

A complete cycle chart for each finished machine is a good quality check and would be useful in event of future questions as to performance and characteristics. Such records are taken by a prominent independent manufacturer on each washing machine produced, requiring a battery of over 100 recording wattmeters.

The principal application for electrical measuring instruments in this field is to enable the operator to achieve optimum performance. The operator is responsible for loading the machines to the optimum point at each phase of the cycle. To guide him in doing this, he needs an instrument to show how heavily he is loading the machine, and how much further he can go.

Presenting Load Information

His interests and requirements in this regard are somewhat different from those of the engineer who designs the equipment. The engineer thinks in terms of allowable torque and horsepower requirements; he usually feels that the indicator should read directly in horsepower or current. But this information may be confusing to the operator. When an operator becomes accustomed to a certain type of dial marking, he may find it difficult to interpret a new one on a different machine (Fig. 2).

It is therefore recommended that a standard dial be adopted which can be used for all applications, *marked in percent load*. Aside from providing operators with a standard, easily understood load indicator, there are many ad-

Presented at the 18th Annual Machine Tool Electrification Forum, sponsored by the Westinghouse Electric Corporation, Buffalo, N. Y., April 6 and 7, 1954.

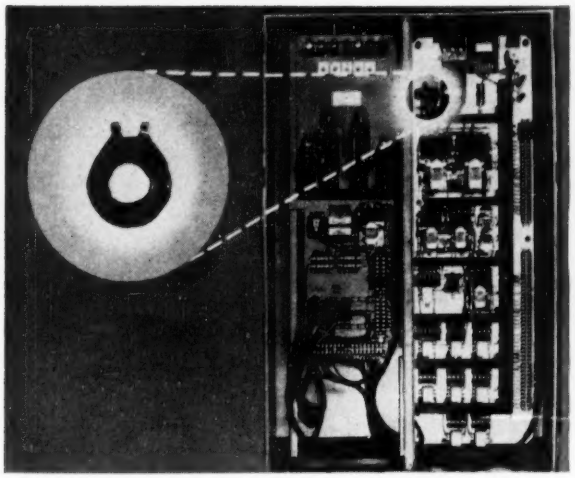


Fig. 3. Control panel showing location of instrument transformer.

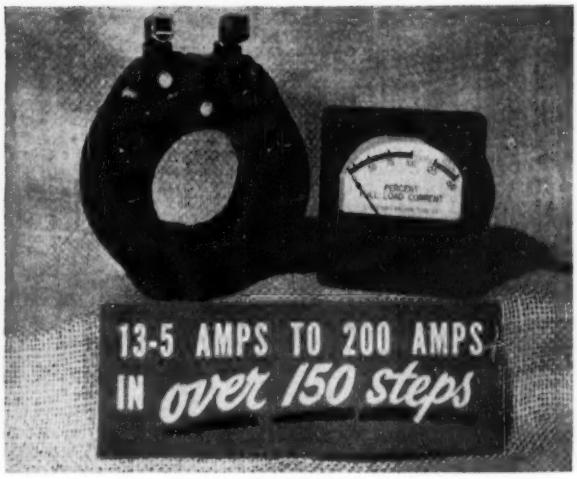


Fig. 4. Instrument transformer.

by D. C. RUSS, JR.
Westinghouse Electric

Load indicators are not merely devices to warn machine operators of overload. Three important functions can be accomplished by load measurement —control, protection, and analysis. A standard load dial is recommended.

vantages to this from the standpoint of both instrument users and manufacturers.

Satisfactory results can be obtained by using the load current of the motor as the measured variable; the actual marking on the dial can be in terms of horsepower, current, percent load current, or percent load, the latter being preferred. However, when measuring a-c. current, the natural tendency has been to select an instrument with a full-scale value equal to or exceeding the expected full-load current of the motor. Invariably this means special calibration of the instrument and high capacities. Such a requirement is highly undesirable for all concerned. It means that each different motor requires a different instrument, which cannot be ordered until the motor rating is determined; machines worth thousands of dollars are often tied up waiting for a 30-dollar instrument to be delivered.

To the manufacturer, this means a series of low-quantity orders for special items.

This difficulty can be avoided by using standard production line five-ampere instruments in conjunction with a ring-type current transformer (Fig. 3). One such transformer can be used to measure primary currents from 13.5 to 200 amperes in over 150 steps, using auxiliary windings to produce a uniform 5-amp. secondary current (Fig. 4). This scheme was proposed by one instrument company before the War, but is still not widely known or practiced.

If we combine with this transformer an indicator marked in percent of full load current, we have a truly versatile combination which will give accurate indication for any motor that can be used, regardless of make or model. In general, two different transformers would need to be stocked, and only one instrument.

We believe that the transformer ratio should be adjusted so that 5 amperes would equal 150 percent of full load, which would bring 100 percent (3.33 amperes) approximately 2/3 of full scale, the most desirable point on the dial for ease and accuracy of reading. The exact dial marking is open to discussion, although uniformity among purchasers would enable faster shipments.

The advantages of such a combination are obvious. One customer has been able to order instruments in lots of 100 with monetary saving due to higher quantity discounts and a lower list price. As the same instrument can be used on all machines, stock is reduced from as many as 10 different types to one. Renewal parts problem is simplified.

Most important of all, the instruments would be available when required. Even if not in stock, 5-amp. ammeters are produced in such quantity that a load indicator in percent can always be shipped.

Mention should be made of a type of instrument specially suited to this application—the socket-type instrument (Fig. 5) with a heavy-duty mechanism, glass cover, and plug-in socket-mounting base. Although cheaper than a corresponding switchboard instrument, it has the same mechanism and accuracy. The transformer may be mounted within the machine or panel, or bolted to the back of the socket.

Installation of sockets also allows ready analysis of conditions by means of a recording ammeter also provided for socket mounting. In this way a chart can be run when the machine is tested or, in event of trouble, while an indicator is used for normal operation.

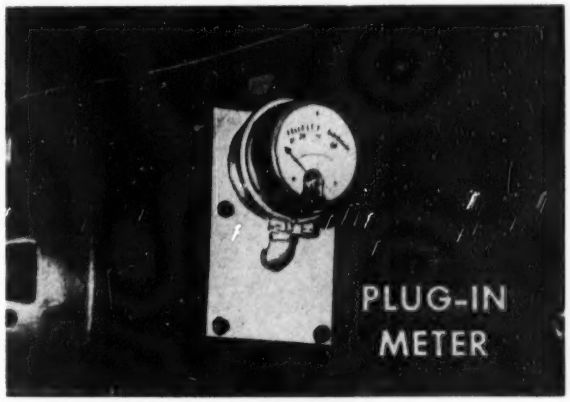


Fig. 5. Plug-in-type load indicator.

Beginning an important series on a provocative subject:

The Automatic Factory —

Preface

This report attempts to bridge the gap between the theoretical concepts and the actual industrial developments of the Automatic Factory. It has been written principally for the American businessman in an attempt to clarify and expose the sometimes hypothetical and imaginative writings of scientific and commercial authors. Dreaming and guesswork have been purposely omitted and those interested in that type of analysis are referred to the "science-fiction" writers. Realism and practicality are, the authors believe, the foundation of this report.

It would be impossible to express our gratitude to the many individuals and corporations who have contributed their time and effort in assisting our research on the Automatic Factory. To those organizations, however, we dedicate our report. We are sorry that space limitations necessitate our acknowledgment of their contributions in a bibliography.

However, the authors wish to extend a special vote of thanks to Nelson Gildersleeve and the General Electric Company; Ralph E. Cross and The Cross Co.; G. G. Murie and The Ford Motor Co.; R. J. Emmert and General Motors; Dr. Donald P. Campbell and the Massachusetts Institute of Technology; L. Davis, D. Smith and The Jones and Lamson Machine Co.; and Chief, U. S. Navy Bureau of Aeronautics and the National Bureau of Standards.

Part I

Introduction

"Automation" and the automatic factory appeal to the imagination of many people. As a result, newspapers, scientific journals, business magazines—nearly everything you read—headline these words. An aura of magic and mystery surrounds them to the extent that they are often considered in two extremes. Messrs. Jewitt and Hawes of Arthur D. Little, Inc., summarize these views by saying: "These articles picture the age of automation, on the one hand, as a science-fiction-type civilization, with robots running machines and tragic mass human unemployment. On the bright side is the concept of a Utopian society with unlimited supplies and everyone spending most of his time in comfortable leisure, perhaps working one day per month. As usual the truth probably lies somewhere in between."

The subject of the automatic factory is becoming increasingly important. The return of a buyer's market and the necessity of competing more on a cost, quality and delivery basis has made this of vital interet. The increasing number of articles and engineering conventions that are devoted to automaticity also have brought about an awareness of the subject.

Publishers have been quick to notice and act on this trend in the businessman's thinking. The magazine which for 28 years was known as *Instruments—the Magazine of Measurement and Control*, is now titled *Instruments and Automation*. Three other publishers have announced their intention to publish new magazines in this field*. In addition, the First International Automation Exposition—to be staged in New York—has been announced for November 29 to December 2, 1954.

The authors hope to reduce the many confusing and contradictory statements by critically reporting the present and what they think will be the future status of automaticity. As stated in the Preface, our research has been focused on the businessman, and it is to these same people that the major part of this work is directed.

Thesis of the Report

This report will support the following conclusions:

1. Interest in automaticity has been accelerated by wartime developments of electronic devices coupled with an increased rate of mechanization. The basic controversy is whether these technological advances are sufficient to bring about automatic factories.

2. The ultimate automatic factory must integrate material handling, processing, inspection and inventory control. These would be governed by closed-loop (feedback) control devices.

3. Obstacles to the achievement of the automatic factory are (a) complexity of production processes, (b) lack of qualified personnel, (c) decentralization of essential skills, and (d) high developmental expenses.

4. Contemporary automaticity indicates that these obstacles will be overcome by evolution rather than revolution. This evolution will develop in various industries according to peculiarities of their individual processes.

5. Cases of current installations show that large savings can be realized by automatizing.

It should be kept in mind throughout this series that the subject matter is "The Automatic Factory," particularly as applied to "piece-part" manufacturing industries, and not "The Automatic Plant," such as chemical plants. The latter have a more-advanced state of automatic control and already make extensive use of a vast array of pneumatic, hydraulic, electric, and electronic devices. Only in use of central supervisory computers of the complex electronic type are the problems of "The Automatic Factory" similar to those of "The Automatic Plant." As use of such computers is an advanced stage of automation, this series pertains specifically and immediately to *automatic factories*.—EDITOR.

*The McGraw-Hill Publishing Co., Penton Publishing Co., and Reinhold Publishing Corp.

Prepared for General Georges F. Doriot in partial fulfilment of the requirements of the manufacturing course at the Harvard Graduate School of Business Administration

A Critical Examination

by STEPHEN A. JUNE
JOHN D. BARDIS
LEE H. LURIO
LEONARD S. POLANER
OYSTEIN SAGEDAHL
HERBERT A. SKLENAR
BERNARD K. YENKIN

6. Social and economic upheavals will not be nationwide, but rather will be local phenomena that can be solved at the individual plant level.

The preceding conclusions will be developed in the next six chapters and be synthesized in a final chapter devoted to the future.

Two appendices will be considered: (1) a management consultant's Manufacturing Cost Determination of "Project Tinkertoy" and (2) a glossary of terms connected with the automatic factory.

Part II

The Automatic Factory In Perspective

To discuss intelligently the future possibilities of automatic factories, it is important to discover what lies behind the present fervent interest in automaticity. What factors have precipitated this interest—and are these important enough to place the automatic factory within the realm of reality? By stating these underlying factors, it is hoped that the confusion now found in any discussion of automatic factories may be eliminated.

State of Confusion

That there is a high degree of confusion can be demonstrated easily. During the research for this report, it was found that the manufacturers and publishers interested in automaticity were not talking about the same thing. Each respondent had his *own* clear idea of what an automatic factory (or automaticity) meant, but these individual ideas did not always coincide. The aggregate was confusion.

For example, a material-handling manufacturer presents the following ideas:

"Our company is vitally interested in many aspects of mechanization and the development of automatic processes. In industry after industry, our conveying machinery plays an important part in reducing costs, increasing production, and easing the burden of labor.

"Actually it would seem that the term 'automation,' though now becoming a very popular word for writers, centers attention on a relatively small portion of this broad field. There are many types of automation in the field of materials handling that perhaps are seldom considered as such. These range from the automatic crushing and sizing of rock at a quarry to the automatic handling of bulk sugar and flour at a bakery."

The implicit assumption behind these statements is that an automatic process consists primarily of automatic handling equipment.

A machine-tool manufacturer looks at automaticity primarily from the standpoint of automatic machining. He makes the following statements:

"The 'automatic factory' and the so-called 'push-button factory' are, in general, probably pretty well understood. When you apply the word automation to machine tools, this seems a little more difficult.

"If I understand the word automation correctly, the so-called station or transfer machines would be the best examples, such as, the transmission case machines and the engine block machines. Machines such as Cross builds, which are equipped with milling cutters for face milling, rocking fixtures to present several surfaces to the tools, drilling, reaming, tapping, spot facing, etc., employing some ten or twelve stations with approximately 180 cutting tools—these are fine examples. In the past this case job would require possibly as many as 50 individual general purpose machine tools with manual handling between each operation. In this case 'automation' is substituted for manual handling.

"Another example is the Cincinnati 'engine block broach' machine. In this particular case this machine displaced some 60 operators and substantially the same number of machine tools, together with a large quantity of fixtures."

Thus, in this statement the movement toward automatic factories is defined in terms of automatic machining (or processing) as well as in terms of automatic handling.

A manufacturer of control equipment states:

"For years, machines have eliminated the need for heavy muscle work on the part of human labor. Now mechanization begins to replace the sensory mechanism of man as a control device. Further, to a limited extent, computer and program controlled machines take over some of the brain functions of man, such as memory, choice, checking, etc.

"The problem that confronts the machine tool builder and the control specialists in extending use of computer controlled machines is twofold: First, development of sufficient understanding of control possibilities related to production needs, and second, actual design, manufacture, and profitable sale of computer controlled machines."

In this statement emphasis is placed on the importance of automatic control devices, an emphasis not appearing before, and yet all three statements purport to be discussing

What is actually new in this "new technology"?

the same phenomenon—the automatic factory. Clearly, people are confused.

Semantics and Confusion

Part of this confusion can be traced to the introduction of a new word—"Automation"—to describe certain phenomena in connection with progress toward automatic factories.

The word automation was coined originally by Mr. D. S. Hurder, Vice President, Manufacturing, at the Ford Motor Company. He defined it as the mechanized handling of materials. Automation by this definition can be narrowed to specific conveyor equipment.

A later user of the word, John T. Diebold, used the term as a contraction of the word automatization, and defined it to mean "both automatic operation and the process of making things automatic." However, he emphasized feedback control.

Therefore, the word "automation" has two meaning—one narrow, the other broad. Confusion resulted because in using the word people do not designate which definition is implied. Moreover, some writers on the subject have jumped back and forth indiscriminately among several definitions. The use of the word "automation" has become a convenient means by which clarification could be avoided. But unless a clarification is made, the writings are "full of sound and fury, signifying nothing."

[A definition proposed by Milton H. Aronson (Technical Editor of *Instruments & Automation* and Editor of *Instrument & Apparatus News*) is more precise in defining the motives and devices used in automation. His definition states that "automation is the substitution of mechanical, pneumatic, hydraulic, electric, and electronic devices for human organs of decision and effort." This definition includes, and yet differentiates between, decision devices (computers) and effort devices (conveyors, valves, motors). It also points out that specific devices used in automation are mechanical, pneumatic, hydraulic, electric, and electronic in nature—thus emphasizing that such devices are NOT primarily either mechanical conveyors or electronic computers.—EDITOR]

But, even if the word had not been coined, the confusion still would have existed. In the last decade the concept of automatic manufacturing has captured the imagination of many, and when imaginations are aroused, confusion usually results—at least for a period of time. However, the word itself only intensified a confusion that would have existed anyway.

Basic Causes for Confusion

To determine the basic causes for confusion, the factors behind the interest in the automatic factory must be uncovered. Why is the automatic factory even being discussed?

Much of the interest in automaticity can be traced to developments in electronics during World War II. In this period electronic computers were finally brought out of the experimental stage into actual use. Electronics were used for the communication and storage of information.

This was a major step in substituting a machine for part of the human brain. Of course in the past there had been mechanical calculators and office equipment, but these *new* electronic instruments were on an incomparably higher level, both with respect to the complexity of the problems solved and to the speed with which they operated. With these various electronic computing devices, it became possible to control the firing of guns, to guide deadly missiles, etcetera. This was a revolutionary development for warfare. It was now possible (1) to perform automatically a number of dangerous and/or repetitive functions previously performed by the human brain, and (2) to perform tasks that were beyond the capacity of the human brain due to its inability to react fast enough.

The scientists who developed these electronic brains soon began to think of their applications in industry. More important, the companies manufacturing these devices for wartime use realized that the war would not continue indefinitely, and they began to search for their peacetime applications.

At this point, discussion of the automatic factory built up momentum. Scientists argued that if weapons could be controlled automatically, then why couldn't the same techniques be applied to industrial processes? Surely if a fast-moving missile could be controlled, so could a manufacturing process.

Thus, developments in electronics gave impetus to discussions of the automatic factory. This movement was strengthened by a second factor—an evolutionary trend toward more and more mechanization. Mechanization can be defined as the machine replacement of manual tasks performed by the human being.

The pressure of wartime production had stimulated the need for mechanization so that new developments were rapidly taking place. Many of these developments were in the field of materials handling—conveyor belts particularly were being applied more and more in the so-called "piece part" industries.

The convictions of the electronics people were strengthened by these developments in mechanization. They looked at these continuous flow processes—they looked at their own control devices—and they concluded that the two could be combined to create automatic factories. At last it would be possible to replace not only the muscles but also the brains of the man on the production line. The technology would be adequate and would need only to be applied!

Therefore, the cry arose that the automatic factory could be a *reality*. The "new technology" would enable any product to be produced automatically.

What is actually *new* in this technology? The mechanization aspect has been an evolutionary trend which has given no indication of approaching its ultimate. The most important new factor is the computer. And this electronic "brain" is but a means of doing *repetitive work* of the human brain. It cannot take over all the thinking done by the human—only that which can be formulized. The question remains—*is this technology sufficient to allow the development of an automatic factory?*

This question brings out the basic cause of present-day confusion. Many scientists and electronics manufacturers claim that the present technology is sufficient. Other persons claim that our store of knowledge is insufficient to produce an automatic factory. This is the basic disagreement.

The following chapters will attempt to resolve this disagreement.

More than three fourths of the machine tools in use are less than 20 years old, and more than three fourths of their products are small lots. Techniques are presented for adapting these machine tools to automatic operation.

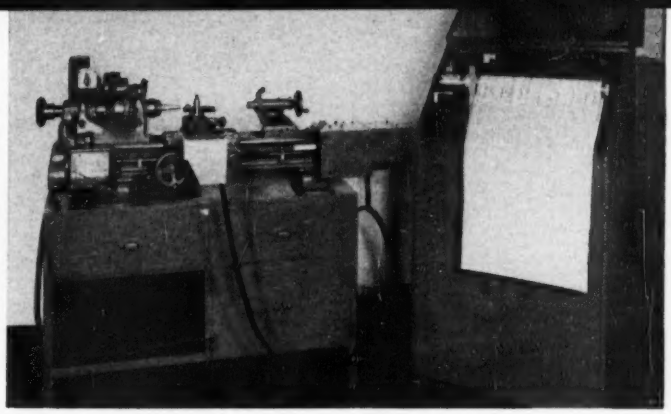


Fig. 1. Engine lathe adapted for tape-controlled automatic operation.

by JULIUS Y. KAPLAN
Arma Corporation

Adapting present machine tools for AUTOMATIC OPERATION

TREMENDOUS PRODUCTIVITY inherent in automatic manufacturing points to the ultimate objective of a completely automatic factory. This objective has been met successfully for products such as chemicals and fluids. In the field of discrete unit production, mass manufacture of highly standardized assemblies is feasible. However, in the field of metal working, 75 percent of the manufacturing in the United States falls in the average lot group of 15 to 50 pieces.[1] Conventional machine tools are not particularly suited to this kind of production, where fast and inexpensive change-over from one product to another is important. Obviously then, before the automatic factory is realized, the more elemental task of automatizing individual machine tools in a reasonably flexible way must be accomplished.

Adaption of many machine tools already on hand should be both practical and feasible. Of the approximately 1,940,000 machine tools in existence in this country, 79 percent are less than 20 years old, and 45 percent less than 10 years old.[2] These machine tools have not and will not be replaced quickly by more productive new equipment. Substantial benefits can accrue to industry now by adapting machines already on hand for automatic operation.

Present Status

Conventional machine-tools available for small-lot production might be one of the three following types: (1) machine tool, manually operated, (2) automatic machine, mechanically programmed and directed by cams, or (3) tracer-controlled machine, guided from a master or template.

The economy of producing more than a few parts by manually operated machines is poor; human factors of fatigue and boredom limit the number of accurate and identical pieces that can be made in a given time; maximum cutting speeds are seldom realized. *Automatic screw machines* require considerable set-up time for change over of collets, cams, and tools. *Tracer-controlled* machines usually are operated from masters or templates easily made from soft materials like plaster or wood. However, production must await the building of a precise large-scale master from a drawing. Complex three-dimensioned shapes with abrupt changes in configuration are not easily made. The stability of masters is questionable, and storage for future orders is an inventory headache.

The unsuitability of these conventional machine tools on small-lot production can be overcome by a tape-controlled servomechanism that features flexibility, fast changeover, and rapid machining cycle.

Technique for Tape Control

Existing means for driving the various machine-tool movements, such as mechanical cams or hand cranks, must be replaced with a drive that may be precisely controlled from a remote source. For this purpose a servomechanism in a closed loop is best suited. The drive response is fed back and compared to the drive order; the difference (error) is strongly amplified and applied to a servomotor, which develops a torque driving the load until response and order are matched.

The next step is to provide an *information-handling system* to link the orders for machining the work piece with the machine-tool servomechanisms. Usually the work order is spelled out on a blueprint, a set of specifications, or tables. These orders are stored by code in a "memory," or information-storage medium. When the machine tool is ready to accept orders, the "memory" is decoded in a translator, or tape-reader unit, which applies the input to the machine-tool control servo.

Presented at the Symposium on Automatic Production of Electronic Equipment, sponsored by Stanford Research Institute and the United States Air Force, San Francisco, California, April 19-20, 1954.

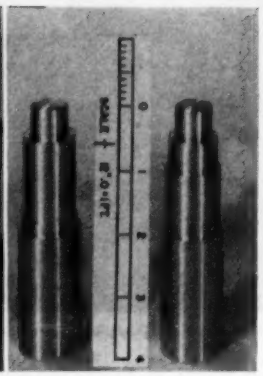


Fig. 2. (left) Tape-punching operation. Fig. 3. (right) Typical parts produced by tape-controlled operation.

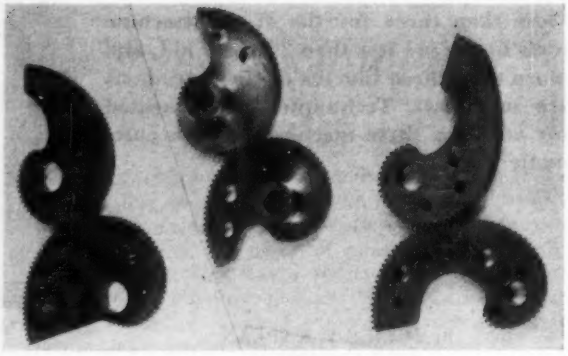


Fig. 4. Gear sets cut by standard gear shaper adapted to cut non-circular gears from tape.

The information-handling system performs two functions: (1) programming operational sequences, and (2) ordering detailed operating instructions.

There are several varieties of *storage media* available. The most common memory types are: (1) Punched cards, (2) punched tape, (3) strip film, (4) magnetic tape or wire, (5) magnetic drums or discs, and (6) dielectric storage device.

In general, information may be coded onto tapes in either digital or analog form. Where a larger fixed order of many significant figures is to be recorded accurately, a digital scheme is more desirable.

Punched tape has the convenient feature that the recording of data is a typewriter operation, and is easily performed, although the mechanical nature of the pickup contacts limits the number of "bits" of information which can be handled per second. Film taping does not provide the serious speed limitation encountered in punched tapes. However, making film is not always convenient.

Although not used extensively at present, magnetic tape seems to offer the highest degree of flexibility of any taping means. Equally adaptable to the storage of analog and digital information, and capable of containing a large density of information per unit volume, it promises to revolutionize many phases of automatic control for industry. Information may be stored on magnetic tape using amplitude, pulse, phase, or frequency modulation.

Conversion of Standard Lathe

Several years ago a standard engine lathe (Fig. 1) was adapted for automatic control from a punched paper tape. The modifications on the lathe consisted in mounting servomechanisms to drive the longitudinal and transverse feeds. Provision was made also for remote turret positioning and speed control of the spindle.

The punched "piano-roll" tape was read by electrical contact fingers, closing circuits through a contacting drum, in accordance with the configuration of punched holes. A group of ten fingers was provided for each digit of a decimal order. The combination of a finger with a hole established an accurate decimal voltage for that digit. A total order, for say a four-digit number, represented the sum of four accurate voltages, a precise analog of the decimal order. This signal was applied as an input, for example to the longitudinal feed servo which drove to precisely match the response potentiometer, giving a null. The tool had then attained the correct longitudinal position.

Provision was made for constant-rate feed by using the tachometer on the servo to match an accurate rate order from the tape. When a tool carriage approached the end of cut position, the servo was automatically switched to positional control, synchronizing the carriage to the proper setting.

To eliminate backlash between the lead screw and tool post, a provision was made for a linear transducer cooperating with a second spring-loaded lead screw. Any backlash is measured by the linear transducer and fed back into the null circuit of the servo, which then automatically cancelled it out.

The servo in this type of machine tool was required to be slightly overdamped because any overshoot would represent an overcut, spoiling the work piece.

The tape-punching operation is demonstrated in Fig. 2. Punching the tape from a drawing of a typical work piece required approximately 15 minutes. The piece could be cut in about four minutes, compared to about 30 minutes for a manual operation by a competent machinist. Tolerances to 0.0003 inch could be achieved.

Using the same size bar stock and the same tool, a new part means only a change in tape. Fig. 3 shows some typical parts cut on the lathe by different tapes.

The components used on the automatic lathe were the standard "brain-block" components available from stock—servo motors, tachometer, potentiometer, etc.

Conversion of Standard Gear Shaper

A "Fellows No. 72" gear shaper was chosen for adaptation. The three basic motions of the shaper—rotation of the work, rotation of the cutter, and workcutter center distance—were quickly fitted with servomechanism drives.

This machine is unique in that it can produce masters or production gears with equal ease at the rate of 25 per eight-hour day. The set-up time is the time required to insert the gear cutter, fasten the gear blank, and thread a strip movie-film "tape" into a 16-mm. projector. A start pushbutton initiates the operation, and the machine stops automatically when the job is done.

A standard gear shaper was converted almost entirely with standard components. In a sense, this adapted gear shaper makes a gear of master accuracy every time, because it is slaved directly to specifications written in the language of the tape. Typical gear sets cut by this machine are shown in Fig. 4.

Table I provides a list of components required to adapt the gear shaper. Not only were the parts standard, but the number required was small, indicating the "reasonable" cost associated with the conversion of such a standard machine to automatic control.

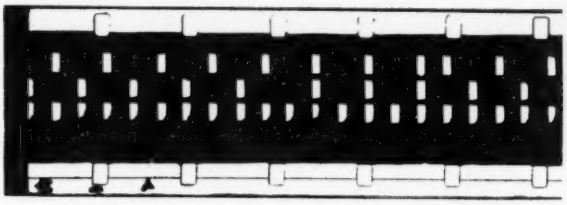


Fig. 5. Section of film for control of gear shaper.

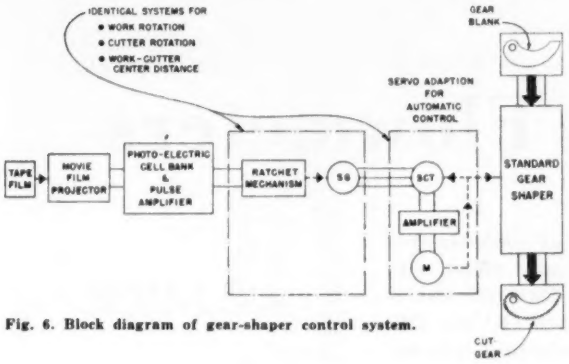


Fig. 6. Block diagram of gear-shaper control system.

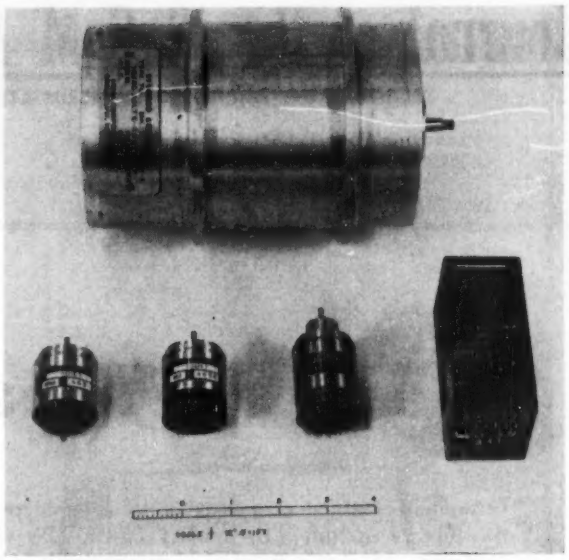


Fig. 7. Miniaturized servo components compared with "Size 7" synchro motor.

TABLE I.—COMPONENTS REQUIRED TO CONVERT STANDARD GEAR SHAPER TO AUTOMATIC CONTROL

Gear Shaper Servos	*Quantity*
Synchro Control Transformer	5
Servo Motor	3
Damping Generator	3
Servo Amplifier	3
Tape Input System	*Quantity*
Phototubes	4
Photo Amplifier	4
Stepping Switch	3
Synchro Generator	5
Movie Projector	1

The motions of the gear shaper's three servomechanisms are directed from orders originating on a motion-picture-film "tape." Data for constructing this tape is calculated for as many discrete points along the curve of the gear as are considered necessary for each of the three motions of the machine. The differences between points are determined, and a linear interpolation is used to establish the spacing of fixed incremental orders.

These orders are put on motion-picture film by photographing the flashes of a row of four lights. A section of the film containing data for the generation of the gear teeth is shown in Fig. 5. In the first column each spot represents 1/100th of a tooth rotation of the cutter. The second column spots represent each 0.00025-in. approach of the cutter to the work. Two minutes of angular rotation of the work is signified for every spot in the third column. A spot in the fourth column stops the machine.

Computing this data requires about 100 hours; putting these values on the film takes about four hours. Seventy-five percent or more of these hours are now in process of being eliminated by a computing instrument.

Once the necessary data is put on the film it is projected continuously on a row of photoelectric cells. The signals are amplified to operate relays. The relays operate ratchet mechanisms which rotate synchro-generators (Fig. 6). The synchro-generators then control the angular position of the cutter, the work, and the distance between their centers through the gear shaper's servomechanism drives. In this manner the gear is generated from the blank. A tolerance of 0.001 inch is held. Gears can be cut of any material machinable on a standard gear shaper.

For this machine the "tape input" is digital, using minute decimal increments to achieve the accurate definition required. The result is a fairly long tape. This is in contrast to the shorter tapes required in the machining of less-complex contours, where large increments may be used. Speed of cutting is a function of the speed of the film.

The relative ease with which the machine can now make noncircular gears of any design directly from specifications, promises to bring about the more frequent use of this valuable component in future machine design.

Advantages

Whereas years ago a large synchro motor might have been required in the remote control of a load, today a handful of miniaturized servo components will do the job, and more accurately (Fig. 7).

The productivity of the lathe in Fig. 1 was increased seven times by automation. Depending on the particular application, a conservative estimate of 200 to 400 percent increase in productivity could be made for most machine tools handling medium-quantity production. Other advantages include: (1) more machines can be supervised than operated; with automatic supervision inherent in the feedback control approach, less inspection and quality control will result. (2) Total labor costs will be reduced. (3) Parts can be made as required—in sets, if desired. Also inventories of cams, masters, and templates are not required. (4) Fewer parts will be spoiled. (5) Greater productivity will mean less machines for the same job; factories can be smaller. (6) Many machines can be controlled from a single tape, if desired. (7) Production control will be simplified. (8) Fast and efficient change-over in production is made possible; customer deliveries can be improved. (9) Complicated configurations are put on tape; the machine only follows. This will permit new designs to evolve. (10) Once a machine tool is adapted for feedback control, gross changes in function can be easily adapted. The rate of obsolescence should be reduced.

Journal of the S C M A . . .

SOUTHERN CALIFORNIA METER ASSOCIATION

President: *Glen C. Wilson*
Vice-President: *Glen G. Gallagher*
Auditor: *Norman Jaffe*
Past Pres.: *James A. Serey, Jr.*
Secretary-Treasurer: *Geo. H. Forster, Jr.*, 640 Fillmore St., Fillmore, Calif.

Variable-area Flowmeters

Important factors associated with proper use of variable-area flowmeters include (1) density effect, (2) viscosity effect, (3) accuracy, (4) body types, (5) rangeability, (6) flow-rate alteration, (7) relative advantages and disadvantages, and (8) use with transmitters, pneumatic instruments, and data-reduction systems.

by D. V. GAYTON
Fischer & Porter Co.

VARIABLE-AREA METER consists of a tapered glass tube incorporated in the piping system with its greater diameter uppermost. Inserted in this tube is an "engineered obstruction," or float, which is free to move vertically in response to flow rate changes. Under steady flow conditions, dynamic equilibrium exists between the downward gravitational forces and the upward velocity effects. Changes in flow rate cause the float to move to a new position seeking a new annular flow area permitting a rebalance of forces.

Although invented as early as 1868, the instrument failed to establish itself because of inability to produce borosilicate glass tubing with uniform internal tapers. The carbon mandrel process of tube forming, introduced in 1931, made the variable-area meter commercially feasible, although still subject to individual calibration. Improved tube-forming techniques and wider developments of body styles have been carried to a point where the instrument today has taken over many of the flow-rate applications in pipe sizes 2-inch and below which were previously reserved for the orifice meter.

The variable-area meter, like its competitor—the orifice meter, uses the familiar equation $V = CA(2gh)^{1/2}$. However, by selecting A (area) as the measured variable, which varies as the first power, the scale calibration is linear, whereas the orifice meter has a square-root scale. The slight inherent departure from exact linearity can be corrected for by tube forming and by linearity adjustments in the receiving equipment. On certain high-accuracy applications the tube is formed on a "characterized" mandrel producing a logarithmic scale for expanded readability at low flows.

October Meeting: Thursday, the 21st, Rio Hondo Country Club, Downey, Calif.

Feature: J. R. Pemberton, Consulting Geologist, will deliver a paper entitled "The Application of Instruments in the Exploration for Oil and Gas."

Density Effect

The basic equation can be developed into working form for liquids to cover corrections for fluid density variations, and for pressure and temperature changes on gas service. All manufacturers publish correction-factor curves or nomographs to assist the user in making these corrections and to aid in meter sizing. The majority of capacity tabulations available from the variable-area-meter manufacturers are listed in terms of gpm. of water and scfm. air when using stainless-steel floats. Therefore, it is important that the user familiarize himself with some form of these correction data in order to select meter ranges for his particular fluid conditions.

Viscosity Effect

Even on micro flows of gases some consideration must be given to the effects and allowable limits of viscosity variation. The solution of this problem has been responsible for the nearly universal application of the instrument on streams of high or variable viscosity.

The balance of forces mentioned previously did not include the effect of viscous forces that radically alter the coefficient C unless special float contours are employed. If a float of streamlined design is exposed to a fluid of high viscosity (petroleum residue, for example) viscous drag will cause the float to assume elevations other than what it would assume were it handling water. By presenting a sharp metering edge to the flow stream, artificial turbulation is set up at the metering area, reducing boundary friction as the flow changes from the laminar region to the turbulent. It might be said that the Reynolds number is momentarily increased at that point. Actually, the sharp-edge design can operate down to Reynolds numbers as low as 1,000 with little or no change in C. Special designs making use of weighted extensions, out of the flow stream, permit operation at even lower values.

In addition to float contour, the degree of immunity to viscous effects depends on other factors—float mass (obviously a float weighing only a few grams can never resist wide viscous changes) and float elevation. Most manufacturers offer float contours of both streamlined and nonstreamlined design, the streamlined design being offered primarily for the purposes of economy with regard to meter capacity. It is interesting to note that one design now available utilizes a metering head that is reversible in contour with respect to the weighted body section. Changing from the sharp edge to the streamlined contour increases meter capacity by roughly 35 percent. In practice there are many services where the smooth contour is permissible, and

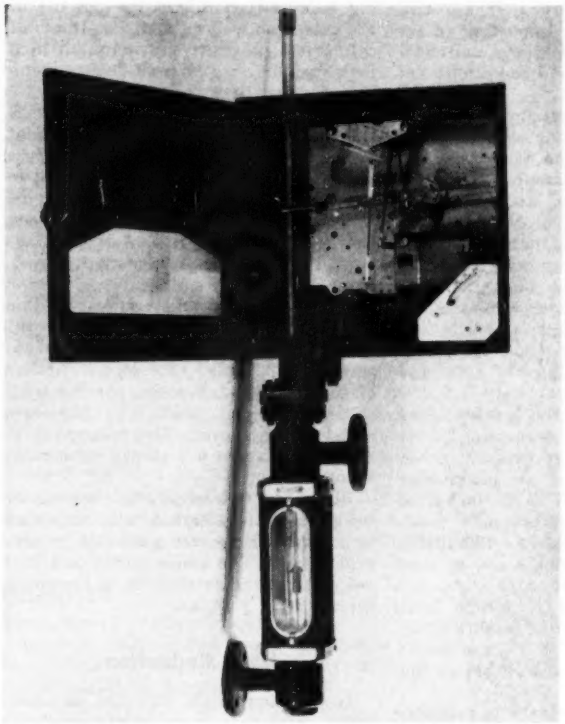


Fig. 1. Industrial-type variable-area flowmeter with magnetic clutch for operating transmitter.

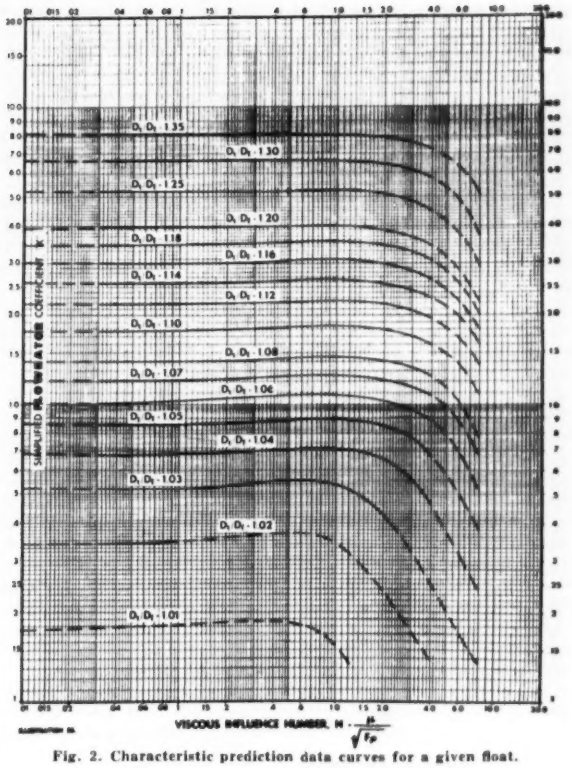

SIMPLIFIED FLOWRATE COEFFICIENT K
VISCOUS INFLUENCE NUMBER, N
D1 D2 - 135
D1 D2 - 130
D1 D2 - 125
D1 D2 - 120
D1 D2 - 118
D1 D2 - 116
D1 D2 - 114
D1 D2 - 112
D1 D2 - 110
D1 D2 - 108
D1 D2 - 107
D1 D2 - 106
D1 D2 - 105
D1 D2 - 104
D1 D2 - 103
D1 D2 - 102
D1 D2 - 101

Fig. 2. Characteristic prediction data curves for a given float.

if high or variable viscosities are not encountered, they are satisfactory. However, research into float coefficients indicates that the sharp-edge float lends itself towards greater predictability when operating over wide Reynolds-number changes.

It has been implied that viscosity immunity is related to float mass (or, more properly, Reynolds number) and that there exists a "ceiling" or point where ability to resist viscous shear diminishes. Prior to 1952, "over-the-ceiling operation" meant individual calibration valid for one specific hydraulic condition only, and applied to that particular tube-and-float combination. This was both costly and confusing. Since that date, much research has gone into float standardization to produce geometric similarity from size to size so that characteristic prediction data could be furnished to the user. Generally, this consists of a graph (Fig. 2) plotting viscous influence number (a form of Reynolds number) as the abscissa, against a simplified coefficient K, with various float elevations (Dt/Df) as parameters.

The coefficient value determined from these basic characteristic curves can be used in standard equations to calculate meter performance over wide viscosity changes.

Accuracy

Variable-area meters are of industrial or research types. "Industrial accuracy" (reserved for 5- and 10-inch meters built to standard data) are not calibrated on a given fluid, but if used in accordance with the manufacturers prediction data of fluids of "near-water" viscosity, the operator can expect approximately 2 to 4 percent of instantaneous accuracy except in the lower 10 percent of the tube. For applications where the viscosity is beyond the reliable limits of available prediction data, or where the meter is to be used on flow-rate totalization of expensive fluids, the industrial-accuracy meter may be subjected to a calibration certification, insuring the user of the 2 to 4 percent accuracy.

For research and test applications, a 24-inch or 600-millimeter glass-tube indicator is used with either a 1 percent of instantaneous guarantee or ½ of 1 percent. Range ratios of these instruments are restricted to about 6:1. The ½-percent-accuracy guarantee is obtained through rigorous and additional fluid calibrations actually simulating the customers hydraulic conditions. One type, particularly useful on gasoline flow measurement, makes use of a unique density-compensation feature; by combining plastic and metal, the float is fabricated to a density of twice the average fluid density. This automatically cancels out corrections due to changes in fluid density across a specified average value. This self compensation is entirely valid for most density changes due to ambient temperature swings and in many cases is broad enough to permit fuel substitutions.

A high-pressure-tube variable-area meter with electronic transmission is available with accuracies of 1 or ½ percent. Receiving elements for these units are either concentric dial indicators or tape scale indicators.

Some multi-tube glass indicators have been offered with guarantees of better than 0.25 percent. These units normally are offered with 2:1 range ratios using as many as 8 to 10 tubes, and with highly restricted limits of fluid density and viscosity. Price tags run high; it is not unusual to have calibration charges alone running over $3,000. Under these circumstances it may be better for the customer to pay more and purchase a primary-standard flowmeter-calibration unit.

Body Types

Approximately sixteeen to twenty standard body types are available from manufacturers. These range from the vest-pocket-type purge meters with plastic bodies to 20-inch connected metal-tube meters for capacities above 6000 gpm. Pressure limitations vary from 15 psig. for the rubber-hose type to 4000 psig. for metal-tube types. Some body types are available as simple indicators; others incorporate transmitting extensions.

Not including purge meters and sight flow indicators, the most popular in-

strument in terms of numbers produced is the 10-inch glass-tube indicator having rotatable end fittings and some type of enclosure for tube protection. Probably the most popular of the various sizes offered is the ½ inch (when furnished with brass or steel end-fittings, price is about $50.00). This unit handles flows up to 2 gpm.

Armored meters have a variety of forms. Some use pressure-equalized glass metering tubes with valve body housings as the pressure-restraining medium. Others, (particularly in the capacity range above 200 gpm.) employ flanged metal tubes inserted between standard pipe tees with overhead-reading extensions. In the range from 2 to 200 gpm., a metal-tube meter is available with inlet and outlet flanges welded to the body portion having suitable outlet adaptor flanges for the various types of extensions available—transmitting, visual indicating or magnetic indicating.

In addition to "full-flow" instruments, the variable-area meter is used as a bypass around an orifice plate, becoming essentially a kinetic manometer. In this instrument a small bypass orifice regulates the bypass flow to the main-line flow, and is calibrated in terms of mainline gpm. Such equipment is used widely in water-treating and steam-flow applications.

Rangeability

Unless otherwise specified, flow ranges of 10:1 are standard; longer ranges can be furnished on demand. However, as there is a hydraulic penalty of increased pressure drop or increased drag, manufacturers attempt to hold to the 10:1 range ratio in industrial applications.

Disadvantages

The disadvantages of the variable-area meter are (1) relative fragility of the metering tube, (2) difficulty of altering flow rate, and (3) higher first cost of the primary element.

The problem of tube fragility is answered by the metal-tube-type instrument, although glass metering tubes can safely withstand surprisingly high pressures. However, pipe strain, hydraulic hammer, or uneven packing gland take-up can cause tube failure at any pressure. The small price difference for the correct type variable-area meter is always justified.

The price of a variable-area instrument is higher, in the same pipe size, than a pair of orifice flange unions and a flat orifice plate. As the cost of variable-area equipment varies roughly as the square of the pipe diameter, cost can become appreciable in sizes over 3 inches. However, every year sees a growing increase in the number of large meters produced.

Advantages

Offsetting the disadvantages are:

(1) *Inherent scale linearity.*

(2) *Long range ratios.* These two items are particularly important in ratio flow-control applications and flow circuits where wide load conditions are encountered.

(3) *Absence of metering runs.* The unit can have valves or elbows placed directly adjacent to the meter inlet.

(4) *Ability to measure sediment-bearing fluids* allows use on starch solutions, paper stock, ore slurries, and plant waste recovery systems. Sanitary versions are in use on milk, tomatoe paste, mayonnaise and beer.

(5) *Viscosity immunity* allows use on molasses solutions, fats and oils, syrups, glue and sizing solutions, petroleum derivatives, sulphuric acid and caustic soda solutions.

(6) *Relatively low and constant head loss* permits pumping economies or use of head tanks. Average pressure drops for standard floats of the sharp-edge design range from 15 to 20 inches of water; streamlined units reach maximum values of as high as 130 inches of water. Souped-up floats can be used to secure high meter capacities, but send differentials sky rocketing. Indicating meters are available with guaranteed maximum drops as low as 0.1 inch of water, and transmitters as low as 1.0 inch.

(7) *Corrosion resistance* is probably the greatest single advantage. Body, tube and float are available in nickel, Hastelloy, tantalum, special bronzes, stainless steel, carbon steel, and cast iron. Special body materials of porcelain, Karbate, Haveg, hard lead, and rubber-lined iron are in use.

Flow-Rate Alteration

The orifice-type instrument is more flexible for altering flow rates. The manufacturer designs variable-area tube-and-float combinations for maximum meter capacity, and any attempts to increase capacity introduces poor performance. Decreasing meter capacity is somewhat simpler; lighter floats are readily available, or weight can be removed from certain portions of the float and the new capacity calculated.

Most of the capacity tables published for indicating instruments list from 2 to 6 ranges available per meter size. These ranges are secured by interchanging floats of various standard weights with one or two different tube tapers. In extension-type meter designs the user may find a span of ranges listed per tube taper.

Transmitters

There are three conventional types of transmitters—the pneumatic (through use of a magnetic clutch), the direct-acting impedance bridge, and the electronic servo-operated impedance bridge. Of these three types the industrial work horse is the magnetic unit, shown in Fig. 1.

The float extension (Fig. 1) houses 2 cylindrical permanent magnets sealed in the extension tube with north-seeking poles adjacent. On the outside of the extension well an additional pair of cylindrical magnets are mounted in a fork fashion on a balance-beam assembly, having their south-seeking poles adjacent to the north-seeking poles of the float-extension magnets. Motion of the float is imparted in a friction-free manner to the balance beam. Owing to the length of the internal magnet, the follower arm can never travel beyond the south-seeking poles of these magnets; this precludes loss of the follower arm.

Performance characteristics of this unit are (1) accuracy within 1-percent full scale, (2) sensitivity within 0.05-percent full scale, (3) reproducibility of 0.25-percent full scale, (4) linearity of 1-percent full scale, (5) full-scale speed of 0.5 second. The follower arm may be linked to a 3-15-psi. pneumatic transmitter.

Both the direct-acting impedance bridge and the electronically amplified impedance bridge are available in several choices. The ample power and fast response of the servo form is becoming increasingly popular.

Data Reduction

In addition to the full line of pneumatic miniature instruments available for use with variable-area-type equipment, there are complete systems for data reduction. This equipment scans hundreds of input signals and transforms the measured variable to contact positions, which converts data acceptable to IBM summary punches, computers, electrical typewriters, teletype systems, and tape punches. These monitoring systems hold great promise for instrumentation economy for industrial applications, particularly in refinery use.

Technical Information

Complaints have been received concerning the numerous changes in technical information. Catalogs are in circulation which are out of date, and it is a difficult and expensive task to assemble, correlate, edit, and publish specific technical information as it becomes available. The great bulk of research has been done by a few companies, with little help from technical societies or institutions. However, standardization of data accumulated over the past two years has now enabled various manufacturers to release handbooks covering selection technique and meter sizing with up-to-date capacity tables, and with density and viscosity corrections. Although some of these corrections may seem complex, it should be emphasized that the variable-area instrument is not simply a sight-flow gadget, but a flowmeter with established technical data to support its theory. This data is available to the user; one of the best ways to increase the use of the variable-area-type instrument is through wider dissemination of engineering data.

Events...

September 29-30

Pittsburgh Conference on Industrial Electronics, sponsored by Professional Group on Industrial Electronics, Institute of Radio Engineers, at the Mellon Institute of Industrial Research, 4400 Fifth Ave., Pgh. 13, Pa. For information contact Dr. James Woodford, Carnegie Tech P. O., Pittsburgh 13, Pa.

October 1-5, 1954

Congrés International de Chronométrie, Paris. For information write R. Baillaud, Directeur de l'Observatoire National de Besancon, Besancon, France.

October 4-6

10th Annual National Electronics Conference, Hotel Sherman, Chicago, Ill. For information write R. E. Hornacek, c/o Illinois Bell Telephone Co., 208 W. Washington St., Chicago 6, Ill.

October 6-7

First Annual National Conference of the Institute of Radio Engineers Professional Group on Nuclear Science, Sherman Hotel, Chicago, Ill. For information write S. J. Goslovich, 517 Forest Ave., Glen Ellyn, Ill.

October 12-15

Eighth National Chemical Exposition, Chicago Coliseum, Ill. For information write Chicago Sec. of American Chemical Society, 86 E. Randolph St., Chicago 1, Ill.

October 13-17

Annual Convention and Fair, Audio Engineering Society, Hotel New Yorker, New York City. For information write C. J. LeBel, Secretary, A.E.S., P. O. Box 12, New York 11.

October 14-15

10th Annual National Conference on Industrial Hydraulics, Hotel Sheraton, Chicago. For information write Conference Secretary, Illinois Institute of Technology, Chicago 16, Ill.

October 25-27

Machine Tool Conference, American Institute of Electrical Engineers, Hotel Statler, Detroit. For information write R. S. Gardner, A.I.E.E., 29 W. 39th St., New York City.

October 28-30

International Symposium on Temperature, at Washington, D.C. Joint sponsors: American Institute of Physics, National Bureau of Standards, U.S. Army. For information write Wallace Waterfall, A.I.P., 57 E. 55th St., New York 22.

November 10-11

Conference on Electronic Instrumentation and Nucleonics in Medicine, Morrison Hotel, Chicago. For information write R. S. Gardner, A.I.E.E., 29 W. 39th St., New York City.

November 3-5

Joint Meeting of Twelth Annual Pittsburgh Diffraction Conference and American Crystallographic Association, Mellon Institute, Pittsburgh, Pa. For information contact P. K. Koh, Allegheny Ludlum Research Laboratories, Alabama Ave., Brackenridge, Penna.

November 21-22

Automatic Control Equipment Exhibition, Waldorf-Astoria Hotel, New York City.

November 29—December 2

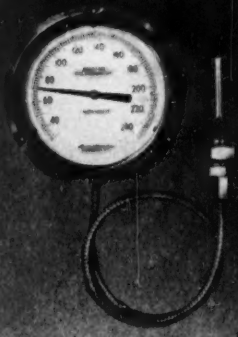
First International Automation Exposition and Computer Clinic, at the 244th Coast Artillery Armory, New York City, N. Y. For information write First International Automation Exposition, 845 Ridge Ave., Pittsburgh 12, Pa.

FOR CONSTANT DEPENDABILITY

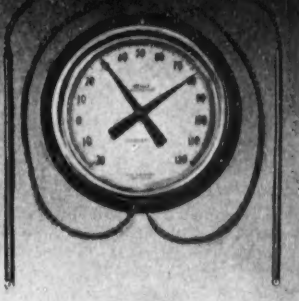
Install

MOELLER

DIALS and RECORDERS

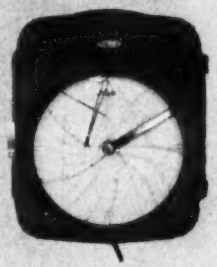


Remote Reading Type, Mercury actuated with separable socket connection. Back connection or flush mounting.

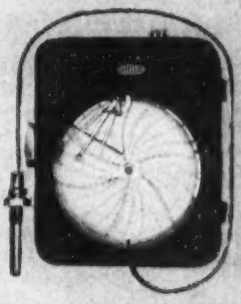


Duplex, mercury actuated, plain bulb type indicates temperatures at two separate points.

TEMPERATURE RECORDING TYPE



Single and multiple pen, Remote Reading types in rectangular or round cases.



Moeller Dial or Recording Thermometers can be furnished with electrical contacts.

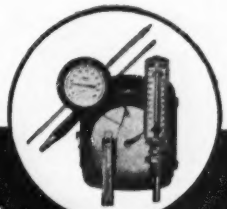
FOUR GENERATIONS have depended upon the accuracy of Moeller instruments.

FOUR GENERATIONS have relied upon the unfailing precision of all Moeller products.

Eighty years of such confidence is proven performance establishes the name Moeller as a guarantee of perfection in the engineering and manufacture of temperature indicating and recording instruments.

Send for catalogs and literature on

INDUSTRIAL, LABORATORY AND RECORDING THERMOMETERS VACUUM GAUGES • HYGROMETERS HYDROMETERS • PSYCHROMETERS AND MARINE SPECIALTIES



MOELLER

INSTRUMENT COMPANY

132nd ST. and 89th AVE. • RICHMOND HILL 18, N. Y.

Representatives in Principal Cities

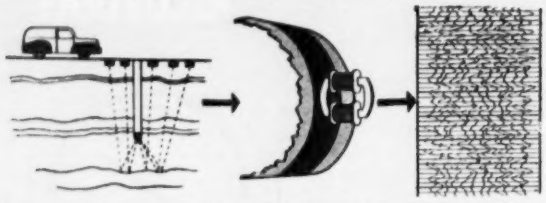
For more information circle **117** on inquiry card.

Briefs . . .

Instruments and AUTOMATION

New Seismic Recorder Technique

Seismic recording of the conventional photographic type provides only a graphic record. This record is not conveniently reproducible as an electrical signal, and the user



who might wish to employ variable filters and apply correlation techniques is severely handicapped . . . The BRUSH magnetic recording system introduces a new technique . . . the full frequency range is permanently preserved and is available for repeated playback . . . provides 24 separate chanels for storage of seismic data and a 25th channel for timing. (*From new 4-page brochure, Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio*).

For this literature circle **501** on inquiry card.

Computer Center

The increasing demands for computation and simulation with analog computers have established a definite requirement for a computation center where problems can be solved by members of industry. Electronic Associates, Inc. at the present time is completing the final details for an analog computation facility. This facility will provide a staff of scientists for problem analysis as well as the rental of time for problem solution. (*From new 12-page loose-leaf brochure, presenting equipment and rental rates, Electronic Associates, Inc., Long Branch, N. J.*)

For this literature circle **502** on inquiry card.

Thermistors

As early as 1834, Michael Faraday noted and recorded the "high negative temperature coefficient of resistance of certain semi-conductors". . . . VECO thermistors are manufactured in three forms: beads, discs or washers, and rods. All . . . are made of various mixtures of the oxides of manganese, nickel, cobalt, copper, uranium, iron, zinc, titanium, and magnesium.

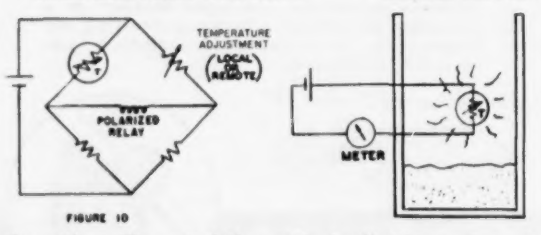


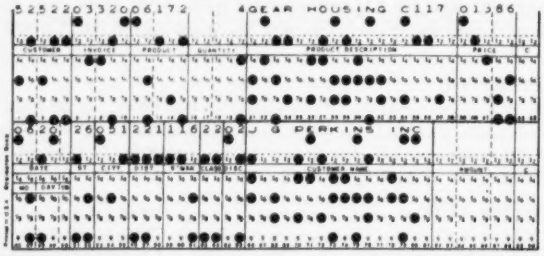
FIGURE 10

Operating Characteristics and Applications: temperatures can be measured and controlled to a precision of one-thousandth degree (0.001 deg.) or less . . . temperature variation of other components can be compensated . . . delays from a fraction of a second to minutes can be obtained . . . gas composition can be measured by thermal conductivity . . . flow rates of gases or liquids can be measured . . . pressure and liquid level can be controlled . . . thermistors are sensitive current and power measuring devices. Instrumentation uses include power indicators, pyrometry, meteorological equipment, vacuum gages, temperature compensation. (*From 40-page "Thermistor Data Book," Victory Engineering Corp., Springfield, Rd., Union, N. J.*)

For this literature circle **503** on inquiry card.

Punch-card Automation

The Multi-Control Reproducing Punch handles 6,000 to 12,000 cards per hour. Typical procedures: Sales statistics —reproduce item name, price cost-of-sales, reports, analy-

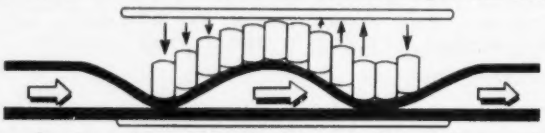


ses, and breakdowns; Payrolls: employee number and hours worked are key-punched on card, gross pay is extended by reproducing from another master deck. Cards from the upper feed can be selectively interfiled with those of the lower feed. Interfiling can be controlled by match or non-match. (*From new 6-page brochure TM817, Remington-Rand, Inc., 315 Fourth Ave., New York 10, N. Y.*)

For this literature circle **504** on inquiry card.

Contact-less Pump

The unique principle of the Sigmamotor makes the pump particularly adapted to the transfer of slurries and solids in solution. The lack of valves allows smooth operation with



no clogging. Also, many highly corrosive acids can be pumped easily. . . . A series of cam-operated fingers press against flexible tubing in sequence and impart a positive unidirectional movement to fluid in the tube. (*From new 8-page brochure, Sigmamotor, Inc., 3 No. Main St., Middleport, N. Y.*)

For this literature circle **505** on inquiry card.

ph and Redox

The pH of a solution may be expressed as the negative exponent of its hydrogen ion "activity" with the minus sign removed. At normal temperatures, pH values below 7 generally indicate acidic solutions, values above 7 alkaline solutions.

Automatic measurement and control of pH values have become more and more important in many of the industrial techniques which surround us since a number of properties of these solutions are subject to control from pH measurements. Process reactions involving neutralization, or reaction to some other pH end-point, are most common, but coagulation, precipitation, surface tension, corrosion, etc., are often pH controllable.

The bulk of pH measurements is today made with glass

For more information circle **118** on inquiry card. ⟶

OHMITE® FOR LONG LIFE .....AND DEPENDABILITY

RHEOSTATS

All-ceramic and metal, close control rheostats for unsurpassed dependability and smoothness of operation. Ten stock sizes, 25 to 1,000 watts.

RESISTORS

A wide range of dependable, fixed, adjustable, tapped, and non-inductive, power wire-wound resistors. Also a wide range of precision resistors.

TAP SWITCHES

Five compact models, 10 to 100 amperes, A.C., up to 12 taps. All-ceramic and metal constructions. Silver-to-silver contacts, with self-cleaning rotor contact.

R. F. CHOKES

Single layer R.F. plate chokes and power line chokes, on steatite or plastic cores. Protected by a special moisture-resistant coating.

Be Right with OHMITE®

WRITE on Company Letterhead for Catalog and Engineering Manual No. 40

OHMITE MANUFACTURING CO., 3615 HOWARD ST., SKOKIE, ILL. (Suburb of Chicago)

USED BY

BOEING

to help build the B-52

ELECTRO DYNAMIC MICROMETER
Model 3600-A

Extremely fine tolerances required in the production of these more than 600 m.p.h. Stratofortresses are made possible with the Electro Dynamic Micrometer. It accurately measures, without contact or "loading" axial or radial displacement to .0001". Also views the amplitude of dynamic movement of any metal body at any speed. Measurements are independent of acceleration or frequency of displacement.

Measures radial expansion due to high speeds
Travel, bounce of relay contacts
Bearing slap in motors
Shaft whip
Eccentricity of commutators, slip rings

Write for Detailed Bulletin DM 1250

ELECTRO PRODUCTS LABORATORIES, Inc.
4501-Id N. Ravenswood Ave., Chicago 40, Ill.

Canada: Atlas Radio Corp., Ltd., Toronto, Ont.

For more information circle **119** on inquiry card.

HIGH PRESSURE PUMP

air driven

FOR PRESSURES TO 30,000 PSI

Measures 8¼" wide x 9⅝" deep

Boost 100 PSI. air pressure to 10,000 PSI. fluid pressure for $173.25 (FOB Gardena, Calif.). Eight standard models for output fluid pressures of 1,000 to 30,000 PSI. Special models for lower or higher pressures.

Applicable wherever low volume output at high pressures is the requirement. For oil or water service. Complete power packages also available. Send for bulletins.

SPRAGUE
Engineering and Sales Corp.
1144 WEST 135TH STREET, GARDENA, CALIFORNIA

For more information circle **120** on inquiry card.

BRIEFS—CONTINUED

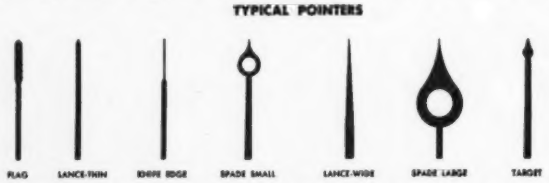
electrodes . . . recent additions to the L&N electrode line are glass electrodes with silver chloride, rather than calomel internal elements. These silver chloride electrodes are primarily used where possible contamination of the measured solution by mercury, present in standard calomel elements, must be avoided.

While reference electrodes and electrode housings used for redox measurements are similar to those used for pH, a platinum electrode is used for measurement, and no Thermohm temperature compensator is provided. (*From new 24-page Catalog EN-S5, Leeds & Northrup Co., 4907 Stenton Ave., Phila. 44, Pa.*)

For this literature circle **506** on inquiry card.

Electrical Indicating Instruments

Space on an instrument panel is valuable. Therefore, it is important to get as long a scale as possible in each instrument. (*From new 52-page Catalog 28, The Hickok Electrical Instrument Co., Cleveland 8, Ohio.*)



For this literature circle **507** on inquiry card.

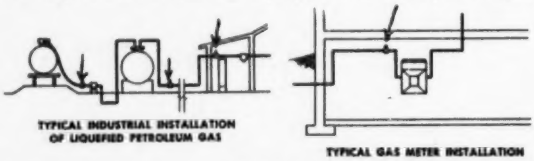
Pneumatic Sine-wave Generator

The Sine Wave Generator (for frequency synthesis analysis) is especially adaptable to pneumatic devices prevalent in industrial control systems. It meets the need for generating sinusoidal air pulses of adjustable frequency, amplitude and mean pressure and providing auxiliary electrical signals for phase reference. (*From new 2-page brochure, Librascope, Inc., 1607 Flower St., Glendale Calif.*)

For this literature circle **508** on inquiry card.

Safety Shut-off Valve

The VALCO is a temperature-actuated automatic shut-off safety valve for use on any type of line (liquid or gas) at any pressure . . . combats fuel-fed fires. (*From new 4-page brochure, Valco, Inc., 1410 West St., Cincinnati 15, Ohio.*)



For this literature circle **509** on inquiry card.

Rupture Discs

Your pressurized equipment undoubtedly is fitted with a relief valve . . . You may also have installed one or more rupture discs to offset the two major weaknesses of the

Type / Dia	A	B	C	D	E	F	G	H	I	J	K
¼"	600	860	1080	1280	1500	1880	2160	2600	2960	3360	3680
½"	300	430	540	640	750	940	1080	1300	1480	1680	1840
¾"	200	287	360	430	500	630	720	870	990	1120	1230
1"	150	215	270	320	374	470	540	650	740	840	920
6"	25	36	45	54	62	79	90	108	123	140	153
7"	21	31	39	46	53	67	77	93	106	120	131
8"	19	27	34	40	47	59	68	82	93	105	115
9"	17	24	30	36	42	52	60	72	82	93	102
10"	15	22	27	32	37	47	54	65	74	84	92

average relief valve. These are (a) a mechanical part may become stuck because of corrosion or clogging; and (b) the opening is not large enough to give complete protection. . . . Dimensions and rupture pressures of common disc sizes are given in the accompanying tables. (*From new 8-page brochure, Baker & Co., 113 Astor St., Newark 5, N. J.*)

For this literature circle **510** on inquiry card.

Panel Indicators

All G-E panel instruments for the measurement of direct current are of the permanent-magnet moving-coil design. . . . All G-E panel instruments for measuring alternating currents and voltage at normal frequencies (25—125 cycles) employ the moving-iron principle. (*From new 12-page bulletin GEC-368F, General Electric Co., Schenectady 5, N. Y.*)

For this literature circle **511** on inquiry card.

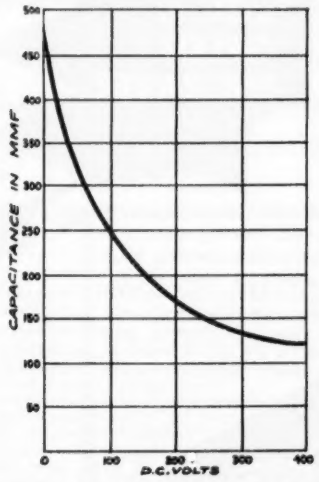
Spectrochemical Excitation Sources

No single excitation circuit or technique is wholly suited to all of the innumerable applications of Spectrochemical Analysis. For example, the DC arc is a source of high sensitivity for the detection of a wide range of elements, but it does not afford the reproducibility of analysis that may be achieved with a high voltage AC spark. The AC spark, however, is without the sensitivity of the former source and in addition gives rise to air lines which may cause interference with the analysis in hand. The DC arc and the high voltage AC spark form extremes, the one of sensitivity and other of reproducibility and between them several other excitation sources have been designed, each a compromise and each emphasizing to a different degree more of one quality than of another. (*From new 8-page Catalog V3-54, Jarrell-Ash Co., Newtonville, Mass.*)

For this literature circle **512** on inquiry card.

Voltage-sensitive Capacitors

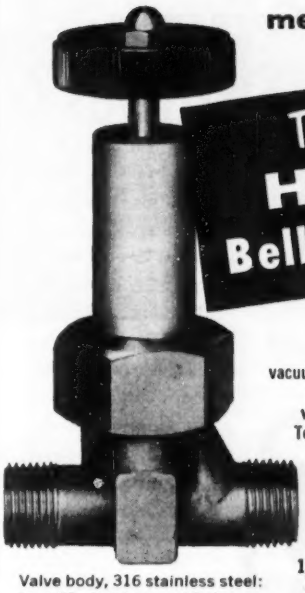
Mucon Corporation has developed a new series of VOLTAGE-SENSITIVE capacitors whose capacitance may be varied by a change in DC potential applied to the capacitor. . . .



The capacitance of Type VSR capacitors will decrease approximately 45% with 100 volts applied DC and approximately 70% with 400 volts applied DC. . . . Voltage-sensitive capacitors suggest unlimited possibilities in tuning and frequency control; frequency modulation, harmonic generation, dielectric amplifiers and many unexplored fields. (*From new 2-page brochure, Mucon Corp., 9 St. Francis St., Newark, N. J.*)

For this literature circle **513** on inquiry card.

where a leak means a loss—



Trust this HOKE Bellows Valve

Designed especially for highly corrosive applications, high vacuum work and mass spectrometry, this 440 Series of small bellow valves provides maximum safety. Tests prove them capable of withstanding more than 100,000 cycles, at low pressure, in non-corrosive service; leakage rate across seat and into valve less than .001 micron CFH.

Valve body, 316 stainless steel: long-life, inert arc-welded bellows assembly, 18-8 stainless steel. Teflon seat and gasket are replaceable. Back-seating design.

1/8" to 1/2", with 1/4" and 1/2" Swagelok tube ends. On special order, available in 1/8" and 1/4" with air operated motor.

Write for complete information

HOKE HOKE INCORPORATED
Fluid Control Specialists
231 S. DEAN STREET, ENGLEWOOD, N. J.

For more information circle **121** on inquiry card.

ELECTRIC and PHOTO-ELECTRIC COUNTERS for every job

Count Anything—Anywhere

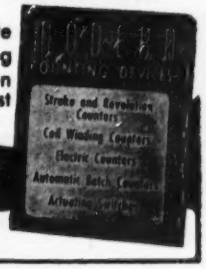
Parts, sheets, bottles, cans, boxes, oranges, people, shadows, box-cars — measure lengths of wire, rope, tape, paper, fabric.

Counting Problems Solved

Helping you stop guesswork, save labor, eliminate waste and avoid human error through automatic counting is our business.

Ask your PIC Representative or tell us what you want to accomplish.

Complete Catalog mailed on request

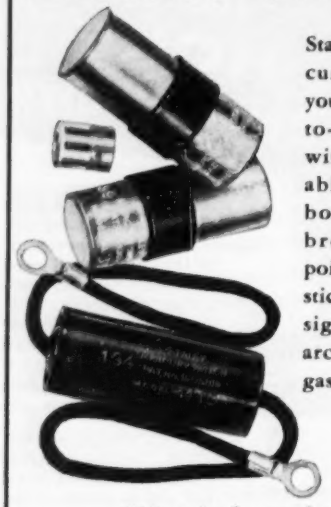


PRODUCTION INSTRUMENT COMPANY
707 W. Jackson Blvd., Chicago 6, Ill.

For more information circle **122** on inquiry card.

Need Dependable

Electric Switches?

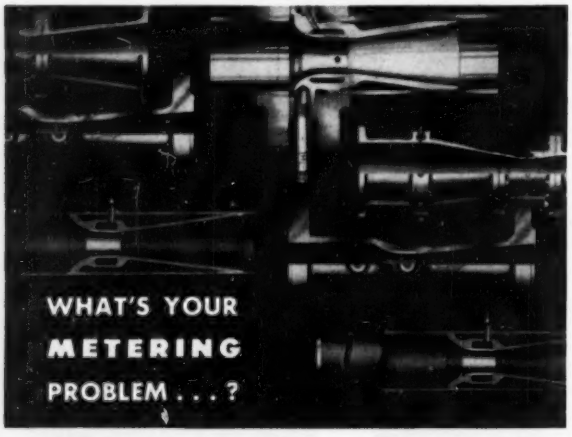


Staley Metallic Mercury Switches give you positive mercury-to-mercury contact within an unbreakable metal cap and body. No glass to break—no switch points to burn, pit or stick. Concentric design and de-ionized arc quench in inert gas. Millions in use.

Write today for complete details to:

ELECTRIC SWITCH CORP.
1307 E. ELEVENTH STREET • COLUMBUS, INDIANA

For more information circle **123** on inquiry card.



BUILDERS can help you, whether your metering problem involves slurries, corrosive fluids, collodial solutions, trade wastes, air, steam, gases, or water. High pressures, high temperatures, minimum pressure losses — these and other job conditions are readily solved by Builders Flow Nozzles and Tubes. Our standard designs answer all types of metering requirements. Units are available in special metals or with Saran lining for corrosive applications.

Address "Nozzles and Tubes" for complete information. Builders-Providence, Inc. (Division of B-I-F Industries, Inc.), 422 Harris Ave., Providence 1, Rhode Island.

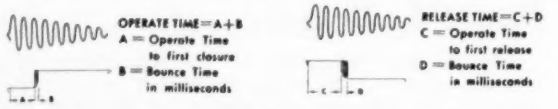
BUILDERS-PROVIDENCE
DIVISION OF B-I-F INDUSTRIES, INC.
MEYERS FEEDERS CONTROLS

For more information circle **124** on inquiry card.

BRIEFS—CONTINUED

Miniature Relays

The "Series 300" d-c. miniature relays feature lightweight design, unusual resistance to vibration and shock and more


OPERATE TIME = A + B
A = Operate Time to first closure
B = Bounce Time in milliseconds
RELEASE TIME = C + D
C = Operate Time to first release
D = Bounce Time in milliseconds

efficient iron-to-iron hinge. Operate time: 10 milliseconds; release time: 5 milliseconds. (*From new 12-page brochure on Computer, Miniature, Coaxial, and Communication Relays, Joseph Pollack Corp., 81 Freeport St., Boston 22, Mass.*)

For this literature circle **514** on inquiry card.

Precision Miniature Bearings

Modern design trends in instrumentation for rotating applications are leading to higher speeds where bearing construction is highly specialized. Bearings must be built to improved accuracies and retainers fabricated from materials other than steel. Phenolic plastic retainers are available in Microtech bearings for these high speed requirements. They are light weight and have superior lubrication and wear characteristics. (*From new 26-page catalog, Microtech Corp., 200 West Colorado, Pasadena, Calif.*)

For this literature circle **515** on inquiry card.

Relays

Relays, arranged according to application, include: Midgets, circuit controls, hermetically sealed, telephone types, impulse types, sensitive types, motor-starting, overload,

Versatility
with a
GREEN
ENGRAVER
ENGRAVES
PANELS
DIALS
PLATES
Mark your own symbols, numbers, lettering, on your small parts, tools, identification and name plates . . easily, simply, quickly . . tracing from a master with the GREEN ENGRAVER.
Widely used in electronic and plastic fields, in machine tool shops and wherever permanent marking is needed.
The GREEN ENGRAVER engraves equally well on metals, plastic, wood, hard rubber and glass.
Routs Models Profiles Engraves
Etching attachment and other special equipment for industrial uses are available.
Fact-filled folder on request showing how economies in costs, labor and time are achieved with the GREEN ENGRAVER.
GREEN
INSTRUMENT COMPANY
383 PUTNAM AVE. CAMBRIDGE

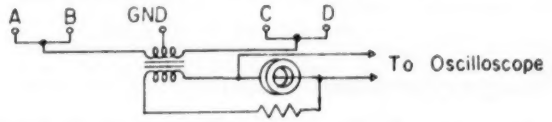
For more information circle **125** on inquiry card.

latch, radio and high-frequency, aircraft relays, contactors (50 to 400 amp.), and inverter types. (*From new 44-page catalog, Leach Relay Co., 5915 Avalon Blvd., Los Angeles 3, Calif.*)

For this literature circle **516** on inquiry card.

Magnetic-Core Tester

The two most common types of core matrices in existence today are the square and rectangular arrays. There are definite advantages to both from the point of view of sig-



nal-to-noise ratio for the readout, and the complexity of the core current driving circuits. In the rectangular array, the short side may be driven either directly by tubes, or transformers coupled to tubes; and the long side by a magnetic switch array. If a binary type switch array is used, a large saving in driver tubes may be realized.

Regardless of the configuration employed however, it is desirable to have uniform cores in the matrix so that the signal-to-noise ratio will not vary to the point where the output information is on the fringe of reliability. (*From new 16-page brochure, Magnetic Core Pulse Analyzer Model MPT-1, Rese Engineering, Inc., 301 Walnut St., Phila. 6, Pa.*)

For this literature circle **517** on inquiry card.

Tachometers, Generators

D.C. permanent-magnet tachometers are used mainly as speed indicating devices. The primary requisites of a speed indicator are: good linearity, minimum temperature varia-

stepless control

no I²R loss

high contact capacity
(UP TO 4.6 KW)

atc®

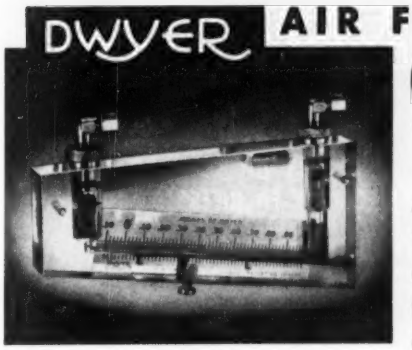
INPUT CONTROLLER

Long, trouble-free service is assured by simple, rugged design for Electrically Heated Ovens, Furnaces, Dryers, Evaporators, Dehumidifiers, etc. Synchronous motor drive. Dial setting determines "on" time of 60-second basic cycle. Flush or surface-mounted.

For complete data write for Bulletin No. J-31. Automatic Temperature Control Co., 5224 Pulaski Ave., Phila. 44, Pa.

For more information circle **126** on inquiry card.

DWYER **AIR FILTER GAGE**



A constant visual check of filter efficiency on ANY system

★

(Exclusive 3-way Dwyer Vent Valve, optional)

Determines exact filter efficiency the *only* practical and economical way—via pressure drop. Dwyer's low first cost is repaid over and over thru savings in replacement and service time, plus maintained optimum filter efficiency.

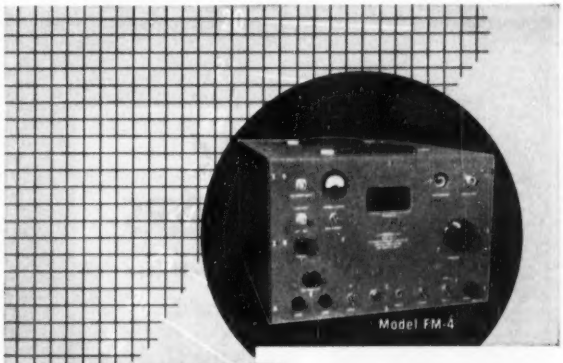
Break-proof plastic construction, life-long accuracy, simple installation, no moving parts to ever wear out or get out of adjustment. Six different scales. A complete unit with all necessary tubing, fittings, etc.

Write for informative catalog page

DWYER *Specialized* **INSTRUMENTS and GAGES**

F. W. DWYER MFG. CO. • 305 SO. WESTERN AVE. • CHICAGO 12, ILL.

For more information circle **127** on inquiry card.



GERTSCH *"New"* **MICROWAVE FREQUENCY MULTIPLIER**

To measure or generate microwave frequencies up to 12,500 mc...

Wide Frequency Range
Continuous Coverage
Extremely High Accuracy and Stability

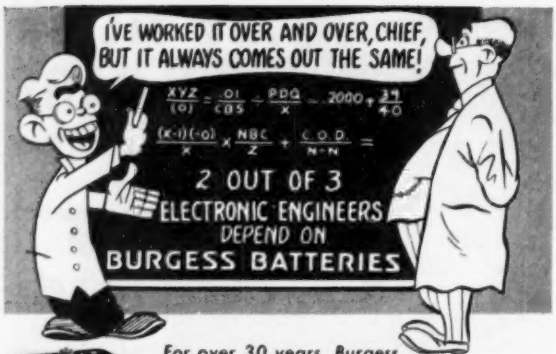
Containing a new and original circuitry development, the FM-4, with suitable driving source allows you to measure frequencies from 100 mc. to 12,300 mc., or to generate frequencies from 500 mc. to 12,500 mc.—with continuous coverage, and extreme accuracy and stability.

ACCURACY: (with Model AM-1 Driver) .00001% (with Model FM-3 Driver) .001%
POWER SOURCE: 105-127 volt, 60-cycle AC

GERTSCH PRODUCTS, INC.

For further information, contact your nearest Gertsch Engineering Representative or write...
11846-48 Mississippi Avenue
Los Angeles 25, California

For more information circle **128** on inquiry card.


I'VE WORKED IT OVER AND OVER, CHIEF, BUT IT ALWAYS COMES OUT THE SAME!
2 OUT OF 3 ELECTRONIC ENGINEERS DEPEND ON BURGESS BATTERIES

For over 30 years, Burgess Batteries have been the popular favorite of electronic engineers, due to their uniform operation and consistently high quality. You'll find a Burgess Battery to fit every need . . . including the all-new transistor types.

No. 4FH

No. Z30NX

Write for FREE engineering manual listing the complete line of BURGESS BATTERIES and specifications, the FREE check sheet to enter new battery specifications, and the new transistor battery sheet.

BURGESS BATTERIES

BURGESS BATTERY COMPANY
FREEPORT, ILLINOIS

For more information circle **129** on inquiry card.

For more information circle **130** on inquiry card.

BRIEFS—CONTINUED

tions, minimum ripple voltage, minimum driving torque, variation due to slot lock, repeatability, no aging effects and good life.

For application where waveform is of prime importance, "ELINCO" sine wave generators are recommended. These units are intended only to supply a signal voltage, they are not capable of delivering any power. The harmonic content is less than ½ of 1 percent. (*From new 28-page Catalog E1-1A, "D.C. and A.C. Generators," Electric Indicator Co., Springdale, Conn.*)

For this literature circle **518** on inquiry card.

Magnetic-fluid Clutch

The magnetic fluid is composed of an iron powder mixed with oil to produce super-smooth operation at low torque levels. . . . . In operation, the clutch body is rotated by means of the base-mounted spur gear. The input signal is applied by carbon brushes to the solid silver slip rings at top. The magnetic lines of force from the signal coil through the working gap change the viscosity of the magnetic fluid, altering the drag on the torque cup and its output shaft. (*From new 2-page Bulletin DL-C 311, Texas Instruments, Inc., 6000 Lemmon Ave., Dallas, Texas.*)

For this literature circle **519** on inquiry card.

Hardness Counter

The automatic counter for the Sward Hardness Rocker was developed by Imperial Chemical Industries, Ltd., for the close study of optimum oven temperatures and drying rates for synthetic and other paint formulations.

It is based upon the Sward Hardness Rocker . . . The rocker is placed on this panel and rolled over to the right so that rocker registers against a mechanical release device

AGASTAT

Compact . . . Dust-Proof

TIME DELAY RELAYS

solenoid actuated—pneumatically timed

Introduces time delays into a-c or d-c circuits. Easily adjusted to provide delays ranging from 0.1 second to five or more minutes.

The AGASTAT is small, light, and operates in any position. Dust-proof timing chamber assures long operating life with a minimum of maintenance.

Write for Bulletin.
Dept. A1-99,

AGA

Division of Elastic Stop Nut Corporation of America
1027 Newark Avenue, Elizabeth 3, New Jersey

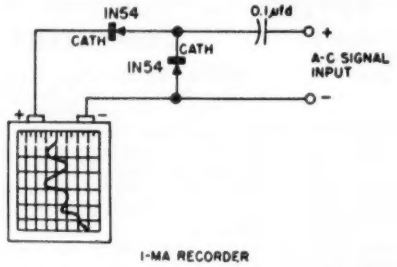
For more information circle **131** on inquiry card.

as shown in the illustration. The release is effected by turning the knurled knob in a clock-wise direction; and, provided the unit has been switched on and correctly levelled, it will count each rock until the amplitude of the Rocker has fallen to a point at which it no longer chops the light beam. The number on the electronic counter is then recorded. (*From 4-page Bulletin* 154, *Gardner Laboratory, Bethesda* 14, *Md.*)

For this literature circle **520** on inquiry card.

Crystal Applications

Direct-writing recorders are used widely for automatic recording of industrial data. Since this is a direct-current instrument, however, Figure 4-4 shows how two 1N54 crystals and a 0.1-ufd. capacitor can be connected ahead of the 1-ma. recorder to adapt it to AC signals up to radio frequencies. (*From new 46-page booklet "Industrial Uses for Germanium Crystals, Sylvania Electric Products,* 1740 *Broadway, New York* 19, *N. Y.*)



For this literature circle **521** on inquiry card.

CHECK, MEASURE, INSPECT with this HANDY
POCKET COMPARATOR
6 Power Magnification
A GREAT TIME SAVER!

Only $24.50 POSTPAID

MEASURES . . .
ANGLES • RADII
CIRCLES
LINEAR
DIMENSIONS
in both decimal inches and mms.

FAST and ACCURATE
On Small Parts . . . Small Dimensions
First time available at such low price! EDSCORP POCKET COMPARATOR. Fine, imported measuring magnifier—for fast, accurate inspections. Black anodized metal coil. Clear plastic base. Focusing adjustment. Used to check layouts, machining on tools, dies, gauges—to check threads, chamfers, small holes. In optical work for checking flaws. Instrument comes in protective leather case. We guarantee complete satisfaction or your money back . . . .
Order Stock No. 30,061-AM . . . $24.50 postpaid. Send check or M.O. or order on open account.

Dealer Inquiries Invited

SPECTRAL LAMPS (famous German Osram Series)
Used in instruments requiring a monochromatic light source or a segment of the spectrum. All lamps fit a standard medium prefocus socket. Supply voltage: 220 A.C. Amperage: 1.0 to 1.5.

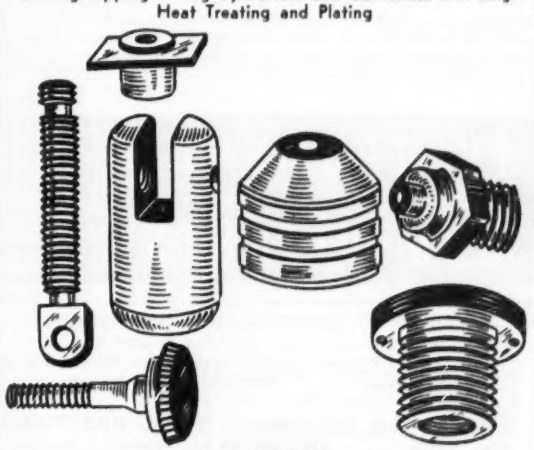
Stock No.	VAPOR	Price Pstpd.	Stock No.	VAPOR	Price Pstpd.
50,054-AM	Cadmium	$29.20	50,060-AM	Sodium	$29.20
50,055-AM	Cesium	29.20	50,061-AM	Neon	29.20
50,056-AM	Helium	29.20	50,062-AM	Rubidium	29.20
50,057-AM	Mercury	29.20	50,063-AM	Thallium	29.20
50,058-AM	Mercury Cadmium	32.30	50,064-AM	Zinc	29.20
50,059-AM	Potassium	29.20	50,065-AM	Mercury Sulphide	38.45

EDMUND SCIENTIFIC CORP., Barrington, N. J.
For more information circle **133** on inquiry card.

Specify THE BEST
• **PHILADELPHIA**
THERMAL CONTROLS AND THERMOMETERS
Our Leadership for nearly a half century is your assurance of complete satisfaction when you specify a "Philadelphia" instrument
Steady, accurate and dependable performance is guaranteed.
PHILADELPHIA THERMOMETER CO.
4400 N. Sixth St. • Philadelphia 40, Pa.
Feel free to consult with our specialized staff on any problem in our field.
SEND FOR CATALOG 110A

For more information circle **132** on inquiry card.

Serving Industry
with **AUTOMATIC SCREW MACHINE PARTS**
ALL SECONDARY OPERATIONS
Drilling-Tapping-Milling-Cylindrical and Centerless Grinding
Heat Treating and Plating



CUTTING DIES OF ALL KINDS
Machine Shop Work—Jigs and Fixtures
PROGRESSIVE SERVICE CO.
Main Office & Factory
2743 Locust St.
St. Louis, Mo.
Tel. Jefferson 1-4300
Branch Office & Factory
80 S. Cameron St.
Harrisburg, Pa.
Tel. 2-8146

For more information circle **134** on inquiry card.

MANUFACTURERS' NEW LITERATURE

In this department we report new literature, pertaining to instrumentation, received from the manufacturers. We urge readers to request ONLY those bulletins which will be of value to them. Use the Postage-free Order Card on Page 1509.

Requests for literature FROM ABROAD should be made on company letterhead and mailed DIRECTLY to the manufacturers.

AUTOMATION

Pneumatic Controllers. New 12-page Catalog 53-10 presents specifications, response actions and selection guide for stack-type pneumatic controllers for process variables. Includes case-mounted, field-mounted and valve-mounted control instruments.—Fischer & Porter Co., 148 Jacksonville Rd., Hatboro, Pa.

Circle **522** on inquiry card.

Quality Control. New 26-page issue of "Taylor Technology" (Vol. 6, No. 4) features article on quality control through temperature recording. Also articles on measurement of flow, new timer-controller, etc.—Taylor Instrument Co., Rochester 1, N. Y.

Circle **523** on inquiry card.

Process Instrumentation. New 4-page issue of "Ratonews" (Vol. 3, No. 6) contains articles on precision-accuracy, high-capacity pump test facilities; and dry-weather sewage measurement.—Fischer & Porter Co., Hatboro, Pa.

Circle **524** on inquiry card.

Control Instrumentation. New 22-page illustrated brochure "Greater Profits Through Consolidated Instrumentation" presents applications of maker's electronic data-processing and recording instruments for production, testing, monitoring and control phases of industry.—Consolidated Engineering Corp., 300 North Sierra Madre Villa, Pasadena 15, Calif.

Circle **525** on inquiry card.

Process Instrumentation Literature. New 16-page Bulletin 100-C lists all current Honeywell Industrial Div. literature. Numbers and titles of all Catalogs, Bulletins, Specification Sheets, and Instrumentation Data Sheets are included.—Industrial Div., Minneapolis-Honeywell Regulator Co., Phila. 44, Pa.

Circle **526** on inquiry card.

Indicating Controller. New set of bulletins describe and illustrate maker's new "Series 400 Capacitrols": 8-page Bulletin F-6314 covers construction and gives operating diagrams; 16-page Educational Bulletin 9 thoroughly covers technical data, operational diagrams, schematic drawings and specifications; and 4-page "Wheelco Comments" (Vol. 14, No. 4) features article on "Series 400 Capacitrols".—Wheelco Instruments Div., Barber-Colman Co., Rockford, Ill.

Circle **527** on inquiry card.

Automation Evaluation. New 4-page brochure contains automation-evaluation chart designed to help executives rate automation possibilities and potentials of their own plants.—T. A. B. Engineers, Inc., Chicago, Milwaukee & Ogden Aves., Chicago 22, Ill.

Circle **528** on inquiry card.

Servo Components. New 22-page Catalog LP-7503 describes and illustrates maker's line of "Hi-Precision" servo components, including servo amplifiers, phase detectors, gear brakes, etc.—Link Aviation Inc., Binghamton, N. Y.

Circle **529** on inquiry card.

Filter Control. New 4-page Bulletin 480-L1 covers description, operation and construction of maker's "Auto-Central" filter control for centralized filter operation and automatic filter backwashing.—Builders-Providence, Inc., Providence 1, R. I.

Circle **530** on inquiry card.

COMPUTERS

Analog Computing. New 50-page catalog describes and illustrates maker's "L3" linear analog computer, "N3" nonlinear analog computer, "R5" six-channel recorder, "R3" two-channel recorder amplifier, "T1" curve follower, and "M1" impedance bridge.—Goodyear Aircraft Corp., Akron 15, Ohio.

Circle **531** on inquiry card.

Computer Center. New 12-page loose-leaf brochure presents equipment, facilities and rental rates of new analog-computation center available on rental basis.—Electronic Associates, Inc., Long Branch, N. J.

Circle **532** on inquiry card.

Air Data Computer. New 8-page Bulletin ADC-1 describes and illustrates maker's new master air-data plug-in-type computer which provides a single coordinated information source for aircraft control.—Servomechanisms Inc., Westbury, L. I., N. Y.

Circle **533** on inquiry card.

Electronic Counter. New 2-page brochure pictures and describes maker's new "Decitron F-1" direct impulse counter.—Electronic Products Div., Post Machinery Co., Beverly, Mass.

Circle **534** on inquiry card.

VALVES

Valves. New 4-page bulletin describes and illustrates maker's packless "Demi" valves, high-pressure valves, and diaphragm-operated "Bantam" valves.—George W. Dahl Co., Inc., Bristol, R. I.

Circle **535** on inquiry card.

Shut-off Valves. New 2-page Bulletin 3024 illustrates and describes maker's "200 Series" shut-off valves for working pressures up to 300 psi., and "100 Series" for low-pressure applications.—Imperial Brass Mfg. Co., Chicago 7, Ill.

Circle **536** on inquiry card.

Valves. New 2-page Bulletin 105 pictures and describes maker's "Series 4000" pilot-operated stainless-steel valves.—Atkomatic Valve Co., Inc., 545 W. Abbott St., Indianapolis 25, Ind.

Circle **537** on inquiry card.

Reverse-Cycle Valve. New 10-page Bulletin 417 presents drawings and description of maker's manually-op-

INSTRUMENT & CONTROL CONSULTANTS
Engineering Services, Testing Laboratories and other Professional Services

Your Midwestern Engineering Facility for the Design of
Control Panels, Instrument Panels & Cubicles
Product Design & Detail — Efficient & Dependable — Production Design Process Engineering
DEARBORN DESIGNING & MANUFACTURING COMPANY
LUzon 2-3069 — 23410 Military Rd., Dearborn 6, Michigan — LOgan 2-6621

C.O.M.S.I.P.
Specialized in control Engineering
Instrument layout—Procurement—Application—conventional and graphic panel design and construction
INSTALLATION—REVAMPING
STARTING UP—MAINTENANCE
40 Ave. Verdun • Croissy • S&O France

Your card in this space in 12 issues of INSTRUMENTS and AUTOMATION for $100, *payable in advance.*

YOU CAN PUMP IN CONTROLLED VOLUME

HYDROCHLORIC ACID... ALL CONCENTRATIONS

CHLORINATED HYDROCARBONS

CORROSIVE METALLIC SALT SOLUTIONS

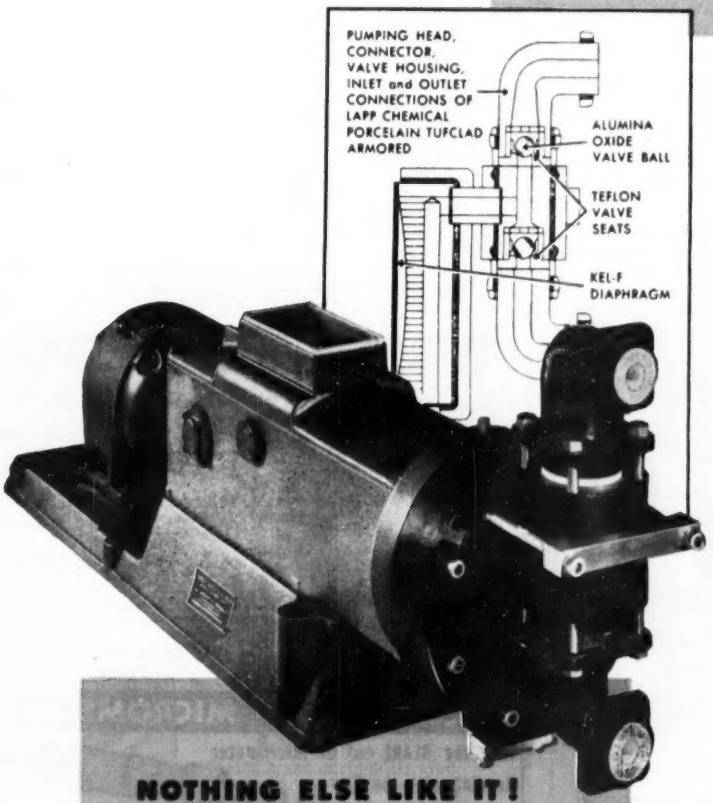
DILUTE ACIDS

MIXED ACIDS

WITH

Lapp PULSAFEEDER

COMPLETELY NON-METALLIC CONSTRUCTION


PUMPING HEAD, CONNECTOR, VALVE HOUSING, INLET and OUTLET CONNECTIONS OF LAPP CHEMICAL PORCELAIN TUFCLAD ARMORED
ALUMINA OXIDE VALVE BALL
TEFLON VALVE SEATS
KEL-F DIAPHRAGM

Solid Lapp Chemical Porcelain, combined with parts of alumina ceramic, teflon and Kel-F plastics, is used for the liquid end of this model of Lapp Pulsafeeder. All parts which can come in contact with liquid being pumped are non-metallic, chemically inert. Thus, positive-displacement metered pumping of "hard-to-handle" corrosive chemicals is made certain and permanently trouble-free.

NOTHING ELSE LIKE IT!

Lapp Pulsafeeder is the combination piston-diaphragm pump for controlled-volume pumping of fluids. Reciprocating piston action provides positive displacement. But the piston pumps only an hydraulic medium, working against a diaphragm. A floating, balanced partition, the diaphragm isolates chemical being pumped from working pump parts —eliminates need for stuffing box or running seal. Pumping speed is constant; variable flow results from variation in piston-stroke length—controlled by manual hand-wheel, or, in Auto-Pneumatic models, by instrument air pressure responding to any instrument-measurable processing variable.

WRITE FOR BULLETIN 300

with typical applications, flow charts, description and specifications of models of various capacities and constructions. Inquiry Data Sheet included from which we can make specific engineering recommendation for your processing requirement. Write Lapp Insulator Co., Inc., Process Equipment Division, 370 Wilson Street, Le Roy, New York.

For more information circle **135** on inquiry card.

NEW LITERATURE

erated reverse-cycle valve for window-type air-conditioning units.—Bridgeport Thermostat Div., Robertshaw-Fulton Controls Co., Bridgeport, Conn.

Circle **538** on inquiry card.

Valves, Pumps. New 4-page Bulletin 35 illustrates and describes maker's corrosion-resistant, micro-regulating needle valves. 6-page Bulletin 36 presents operating principle, general description and performance data for maker's micro-regulating laboratory feed pump.—Whitey Tool & Die Co., 1150 55 St., Oakland 8, Calif.

Circle **539** on inquiry card.

MOTORS

Syncros, Motors. New 34-page Catalog 40 describes and illustrates maker's synchros, d-c. and a-c. motors, inverters, actuators, generators, etc.—Servo-Tek Products Co., Hawthorne, N. J.

Circle **540** on inquiry card.

Miniature Motor. New 2-page Bulletin SR-43 presents electrical and physical characteristics, dimensioned outline drawings and performance data for maker's series-wound 25-watt miniature motor.—Dalmotor Co., 1344 Clay St., Santa Clara, Calif.

Circle **541** on inquiry card.

Motors. New 2-page bulletin describes and illustrates maker's high-speed incremental motors.—Stepper Motors Corp., P. O. Box 466, Culver City, Calif.

Circle **542** on inquiry card.

Motors, Switches. New 16-page Aug.-Sept. issue of "This-Month" illustrates and describes distributor's line of panel meters, switches, transmitters, solenoids, relays, power supplies, motors, circuit breakers, timers, etc.—Herbach & Rademan Inc., 1204 Arch St., Phila. 7, Pa.

Circle **543** on inquiry card.

TEMPERATURE

Temperature-Monitoring. New 8-page illustrated Bulletin 70 covers applications, operation details and specifications of maker's multipoint temperature-monitoring system.—Thermo Electric Co., Inc., Saddle River Township, Rochelle Park P. O., N. J.

Circle **544** on inquiry card.

Temperature Test Chamber. New 4-page illustrated brochure covers description, operating instructions and specifications for maker's "Model TC-2" temperature test chamber.—Statham Development Corp., 12411 West Olympic Blvd., Los Angeles 64, Calif.

Circle **545** on inquiry card.

Thermocouple Wire. New 4-page Bulletin 1200 lists sizes, metals, insulations and applications of maker's thermocouple and extension wire.—Claud S. Gordon Co., 3000 S. Wallace St., Chicago 16, Ill.

Circle **546** on inquiry card.

Tank Heaters. New 2-page Bulletin 5M-10-53 presents description, applications and specifications of maker's "Chill-Chaser" automatic, electric, immersion tank heaters for maintaining liquid temperatures.—Still-Man Equipment Corp., 429-33 East 164 St., New York 56, N. Y.

Circle **547** on inquiry card.

Temperature Control. New 2-page Data Sheet 11297 presents uses, operation, construction, features and dimensions of maker's "Lo-Temptrol" low-temperature bath and circulating system; 2-page Bulletin 647 covers operation and features of "Micro-Set" thermoregulators.—Precision Scientific Co., 3737 Cortland St., Chicago 47, Ill.

Circle **548** on inquiry card.

Temperature Regulators. New 12-page Bulletin S-6 describes and illustrates maker's self-contained vapor-pressure-operated thermostatic temperature regulators for automatic control of flow of liquid or steam through a valve.—Lawler Automatic Controls, Inc., 453 North MacQuesten Pkwy., Mt. Vernon, N. Y.

Circle **549** on inquiry card.

Thermoregulator. New 2-page Catalog 15 illustrates and describes maker's "Quick-Set" thermoregulator which controls temperature within 0.02 deg. F.—Philadelphia Scientific Glass Co., Abington, Pa.

Circle **550** on inquiry card.

Heating-jacket Tubes. New 8-page illustrated Bulletin B-90 discusses performance characteristics, temperature control and applications of maker's "E-C" coated tubes for laboratory heating jackets.—Corning Glass Works, Corning, N. Y.

Circle **551** on inquiry card.

the most widely used
Electronic Supply Guide
free send for it
ALLIED'S
COMPLETE 308-PAGE
1955 CATALOG
your guide to the world's largest stocks of
ELECTRONIC SUPPLIES FOR INDUSTRY
Simplify and speed all your purchasing of electronic supplies and equipment. Send your orders to us for fast shipment from the world's largest stocks of electron tubes (all types), test instruments, audio equipment, electronic parts (transformers, capacitors, controls, etc.). Our expert Industrial supply service saves you time, effort and money. Send today for your FREE 1955 ALLIED Catalog—the complete up-to-date guide to the world's largest stocks of quality Electronic supplies for Industrial use.
One complete dependable source for everything in electronics
ALLIED RADIO
100 N. Western Ave., Dept. 50-J-4
Chicago 80, Illinois

For more information circle **136** on inquiry card.

ULTRA-CHEX GAGE BLOCKS
for Every Need!
Supplied in one Superior Accuracy
5 MILLIONTHS ± ACCURACY
34 BLOCK SET.....$125.00
(Shown) Code GADHI
Incl. Opt. Parallel
82 BLOCK SET.....$275.00
Code GHEYS In Case
9 BLOCK SET
FOR INDIVIDUAL MECHANIC
$22.50
Opt. Parallel $5.00 Extra
Code GADFO
These Sets will supply the needs of any discriminating shop that must work to gage-block precision.
IMMEDIATE DELIVERY
Write for Illustrated Folder—Code GINVU
"Lustro-Chrome" MICROMETER
Take the GLARE out of Micrometer Reading with the New "Lustro-Chrome" MICROMETER
MEASURE TO 1/10,000th
No. 901C
0-1" Size with LOCK NUT and RATCHET and 10th Vernier as shown
$13.25
Code GHAEF
All graduations are well-defined black lines on dull chrome surface for easier and surer reading, even in poor light. Guaranteed accurate within one half of a ten thousandth of an inch.
This tool with TUNGSTEN CARBIDE tipped anvils $15.75
Code GHAEF-CA
Drop-forged model with chrome finished micrometer head from $8.25 up.
Ask for Micrometer Catalog—Code GINWY
GEORGE SCHERR CO., Inc.
COMPLETE LINE OF PRECISION INSTRUMENTS
200-MG LAFAYETTE ST. • N.Y. 12, N.Y.

For more information circle **137** on inquiry card.

PRESSURE, WEIGHT

Pressure Transducer Designs. New 8-page issue of "Instrument Notes" No. 27 discusses evaluation of designs of transducers for measurement of dynamic pressures in liquid systems. —Statham Laboratories, Inc., 12401 West Olympic Blvd., Los Angeles 64, Calif.

Circle **552** on inquiry card.

Pressure Transducer. New 2-page bulletin presents photographs, diagrams and description of maker's new "Type P-1" absolute-pressure transducer.—E. V. Naylor Laboratories, 30 Manorhaven Blvd., Port Washington, N. Y.

Circle **553** on inquiry card.

Electronic Scale. New 4-page illustrated brochure and 2-page Bulletin 102 presents description, applications and specifications of maker's "briefcase" size, 2-ton weighing capacity, portable, platform-model electronic scale.—Control Cells Corp., 511½ North Hillside, Wichita 6, Kansas.

Circle **554** on inquiry card.

FLOW

Flow Measurement. New 8-page Bulletin 190 lists features, applications and dimensions of maker's "Flowmizer" low-cost rotameter, "Flo-Gard" for high- or low-flow alarms, and small-flow purge meter.—Brooks Rotameter Co., Lansdale, Pa.

Circle **555** on inquiry card.

Hydraulic Flowmeters. New 16-page Bulletin 700 describes and illustrates maker's line of bucket-wheel-type current meters, including saltwater model, pygmy-type, electric, etc.—W. & L. E. Gurley, Troy, N. Y.

Circle **556** on inquiry card.

Wind Recorder. New 2-page illustrated Bulletin 170 presents description and specifications of maker's "Model 170-2" wind-speed and wind-direction recorder for meteorological research.—Beckman & Whitley, Inc., 1096 San Carlos Ave., San Carlos, Calif.

Circle **557** on inquiry card.

Anemometer Probes. New 4-page brochure illustrates and describes maker's line of hot-wire anemometer probes for research and industry.—Flow Corp., 283 Concord Ave., Cambridge 38, Mass.

Circle **558** on inquiry card.

Multiple-stage Flowmeter. New 2-page Bulletin 1053 presents design and construction features of maker's "Type 12—100 Series" multiple-stage flowmeter with various combinations of variable-area metering tubes.—Commercial Research Laboratories, Inc., 20 Bartlett Ave., Detroit 3, Mich.

Circle **559** on inquiry card.

Pumps, Alloys. New 2-page illustrated P-3a describes maker's line of centrifugal pumps; 20-page Bulletin PI-3b covers applications and physical properties of maker's corrosion-resistant alloys for process industries; 2-page bulletin lists pump distributors; 12-page brochure is report to stockholders for 1953.—Ampco Metal Inc., Milwaukee 46, Wis.

Circle **560** on inquiry card.

RECORDING

Oscillographs, Amplifiers. New 4-page illustrated bulletin is application reference guide for maker's oscillographs and amplifiers.—Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio.

Circle **561** on inquiry card.

Recording, Strain. New 12-page issue of "Hathaway Engineering News" (Vol. 4 No. 2) contains articles on biological testing instruments, filar accelerometer, static and dynamic strain measurements, and portable stand for maker's "RS-9" oscillograph. —Hathaway Instrument Co., 1315 South Clarkson, Denver, Colo.

Circle **562** on inquiry card.

Tape-recorder Inverters. New 2-page Catalog 254A describes and illustrates maker's inverters designed for operating standard a-c. tape recorders, dictating machines, etc. from d-c. automobile storage batteries.—American Television & Radio Co., St. Paul 1, Minn.

Circle **563** on inquiry card.

RADIOACTIVITY

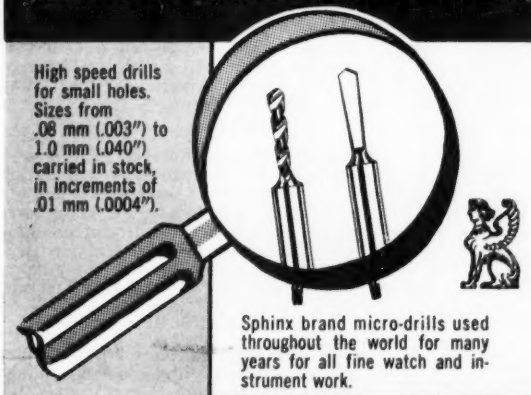
Scintillator. New 2-page Bulletin 8-52 describes and illustrates "Models 111 and 115" portable scintillation counters; also "Models 107 and 106" geiger counters.—Radiac Co., 489 Fifth Ave., New York 17, N. Y.

Circle **564** on inquiry card.

Scintillation Counters. New 6-page illustrated brochure describes maker's scintillation counters for laboratory

"IN-STOCK" SERVICE ON FAMOUS SPHINX BRAND MICRO-DRILLS

High speed drills for small holes. Sizes from .08 mm (.003") to 1.0 mm (.040") carried in stock, in increments of .01 mm (.0004").



Sphinx brand micro-drills used throughout the world for many years for all fine watch and instrument work.

Send for Bulletin N listing sizes and prices of stock drill sizes and micro-drilling equipment.

These precision drills are available in two styles, flat pivot drills or spiral fluted drills. They are made with concentric oversize shanks. Because of their rigidity they are especially useful in all types of drilling equipment.

LEVIN Louis Levin & Son, Inc.
3610 South Broadway • Los Angeles 7, California

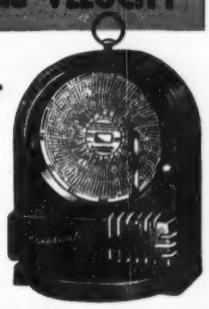
For more information circle **138** on inquiry card.

Instruments for Measuring AIR TEMPERATURE and VELOCITY

TEMPSCRIBE
Recording Thermometer

Available in 10 different ranges to cover −30°F to +160°F temperatures, and with spring-operated chart drives for any of the following chart rotations: 8 hours, 24 hours or 7 days.

This entirely self-contained, compact and reliable temperature recorder automatically writes a continuous record of temperature changes on a replaceable chart. Record shows at a glance maximum and minumum temperatures and the duration of temperatures above or below any given point; also shows the exact time of every temperature change and how rapidly it takes place. Recording pen and bi-metallic element are built in hinged, removable door which is also front of instrument. Thus, by merely changing doors it is easy to interchange temperature ranges. Instrument is 8" tall, 5½" wide and 4½" deep. Charts are 4½ inches in diameter.



Write for Bulletin I-715

FLORITE Anemometer

In principle, this unique instrument operates as an anemometer but provides instantaneous, direct readings of air velocity without timing, calculations or reference to charts. Readings are obtained by holding the instrument in the air stream so that air blows against its circular face, causing rotation of a multi-blade rotor mounted in instrument housing. The circular scale surrounding the rotor instantly turns to correct air velocity reading under an index pointer on scale window. Furnished with detachable handle (not shown) and leather case.

Available in two styles: One with a scale of 0-1000 ft./min., and the other with a double scale of 0-3000 ft./min. and 0-35 miles per hour.

Write for Bulletin I-760

BACHARACH Industrial Instrument Co.
7301 PENN AVENUE • • PITTSBURGH 8, PA.

For more information circle **139** on inquiry card.

On "Utiliscope" receiver, operator "sees" distant or dangerous operation in comfort and safety.

With THE DIAMOND "UTILISCOPE" (WIRED TELEVISION)

The "Utiliscope" (wired television) enables you to see where you can't look. Its camera eye can be placed in dangerous, remote or inaccessible spots and it will bring an exact image right to the operator. Moreover, several cameras can observe various parts of an operation or several related operations. Images of these directly in front of the operator enable him to accurately control the whole . . . concentrating responsibility and avoiding mistakes through erroneous information.

The "Utiliscope" saves manpower, improves product quality, increases production and prevents accidents. No special skill is needed for installation and operation. Its stability and reliability are exceptional. Use coupon below for further information.

"Utiliscope" Receiver — "Utiliscope" Camera

6845

DIAMOND POWER SPECIALTY CORP. IN LANCASTER, OHIO

Please send me without obligation a copy of new Bulletin No. 1136 showing how the Diamond "Utiliscope" (Wired Television) is being used to cut costs, improve operations and promote safety.

Name_____

Company_____

Address_____

DIAMOND POWER SPECIALTY CORP.
FIRST IN INDUSTRIAL TELEVISION
LANCASTER, OHIO
OFFICES IN 39 PRINCIPAL CITIES
Diamond Specialty Limited — Windsor, Ontario
Since 1903, Diamond has Manufactured Quality Equipment for Industry

For more information circle **140** on inquiry card.

NEW LITERATURE

and clinical applications.—N. Wood Counter Laboratory, 5491 S. Blackstone Ave., Chicago 15, Ill.

Circle **565** on inquiry card.

X-ray Dosemeter. New 2-page Brochure 125 presents description, operation and specifications of English-made X-ray dosemeter.—The Atomic Center, Inc., 489 Fifth Ave., New York 17, N. Y.

Circle **566** on inquiry card.

Geiger Counter. New 2-page bulletin describes and illustrates maker's "Prospector" geiger counter "Model GC-238."—The Radiac Co., Inc., 489 Fifth Ave., New York 17, N. Y.

Circle **567** on inquiry card.

OPTICAL

Optics. New 104-page catalog pictures and describes more than 1,000 optical items including telescopes and accessories, industrial quality control tools, microscopes and accessories, photographic equipment, lenses, prisms, wedges, etc.—Edmund Scientific Corp., Barrington, N. J.

Circle **568** on inquiry card.

Industrial Periscopes. New 4-page Bulletin 301 describes and illustrates maker's industrial periscopes for special assignments in remote viewing.—Kollmorgen Optical Corp., Northampton, Mass.

Circle **569** on inquiry card.

Metallograph. New 6-page brochure pictures and describes features of new "Model MeF" metallograph which performs all known methods of microscopic examinations, including surface finish, phase contrast, macro-photography, etc.—William J. Hacker & Co., Inc., 82 Beaver St., New York 5, N. Y.

Circle **570** on inquiry card.

Microscope. New 2-page illustrated Bulletin A-145 presents description, optical data and instruction for using maker's "Model A" wide-field microscope for industrial work.—Testa Mfg. Co., 418 So. Pecan St., Los Angeles 33, Calif.

Circle **571** on inquiry card.

Color Quality Control. New 2-page bulletin describes, illustrates and discusses applications of maker's "Trichometer" for measurement, continuous observation and/or recording of all color characteristics.—Kaye Development Co., 79 Prospect St., Stanford, Conn.

Circle **572** on inquiry card.

Laboratory Microscopes. New 28-page illustrated Booklet D-185 outlines uses, performance data and specifications on more than 60 microscope models and accessories.—Bausch & Lomb Optical Co., 635 St. Paul St., Rochester 2, N. Y.

Circle **573** on inquiry card.

ANALYTICAL

Gas Detector. New 4-page Bulletin 501 pictures and describes maker's supersensitive gas detector for detection of hazardous gases in low concentration.—Taller & Cooper, 75 Front St., Brooklyn 1, N. Y.

Circle **574** on inquiry card.

Analytic Instrumentation, Recording. New 16-page issue of "CEC Recordings" (Vol. 8 No. 2) presents articles on cycloidal mass spectrometer, wind-tunnel measuring system, mobile instrument lab, coding in industry, etc.—Consolidated Engineering Corp., 300 North Sierra Madre Villa, Pasadena 15, Calif.

Circle **575** on inquiry card.

Analytical Instrumentation. New 8-page Beckman Bulletin 14 contains articles on recording spectrophotometer, special electrodes, clinical colorimeter, dark glasses and infrared spectroscopy.—Beckman Div., Beckman Instruments Inc., 2500 Fullerton Rd., Fullerton, Calif.

Circle **576** on inquiry card.

Chemical Testing Equipment. New 102-page 1954 General Catalog describes and illustrates maker's chemical controls, soil-testing equipment and blood-chemistry outfits.—LaMotte Chemical Products Co., Towson, Baltimore 4, Md.

Circle **577** on inquiry card.

Viscometer. New 8-page illustrated brochure presents detailed description, measuring principle, range of application, etc. of maker's structural, recording and regulating viscometers.—Drage Products, 406 32nd St., Box 330, Union City, N. J.

Circle **578** on inquiry card.

Infrared Source, Controller. New 2-page Bulletin ODC-409 covers features, uses, description, and specifications of maker's "Type RS-1A and TC-2A" infrared reference source and controller.—Olympic Development Co., 30 Commerce Rd., Stamford, Conn.

Circle **579** on inquiry card.

X-ray Diffraction. New 16-page "Norelco Reporter" (Vol. 1, No. 6) features article on applications of X-ray diffraction in the environmental field, and includes articles on low-element detection, identification of single crystals from cell dimensions, and on maker's 75-kv. electron microscope.—North American Philips Co., Inc., Mount Vernon, N. Y.

Circle **580** on inquiry card.

Paper Electrophoresis. New 4-page Bulletin 4R-554 presents description and specifications, and illustrates operation of maker's paper electrophoresis system including all instrumentation for standardized operating procedure.—Specialized Instruments Corp., 688 O'Neill Ave., Belmont, Calif.

Circle **581** on inquiry card.

Electroanalysis. New 2-page Bulletin 370 describes and illustrates maker's single-position electronalysis apparatus for quantitative analysis of metals.—Eberbach Corp., Ann Arbor, Mich.

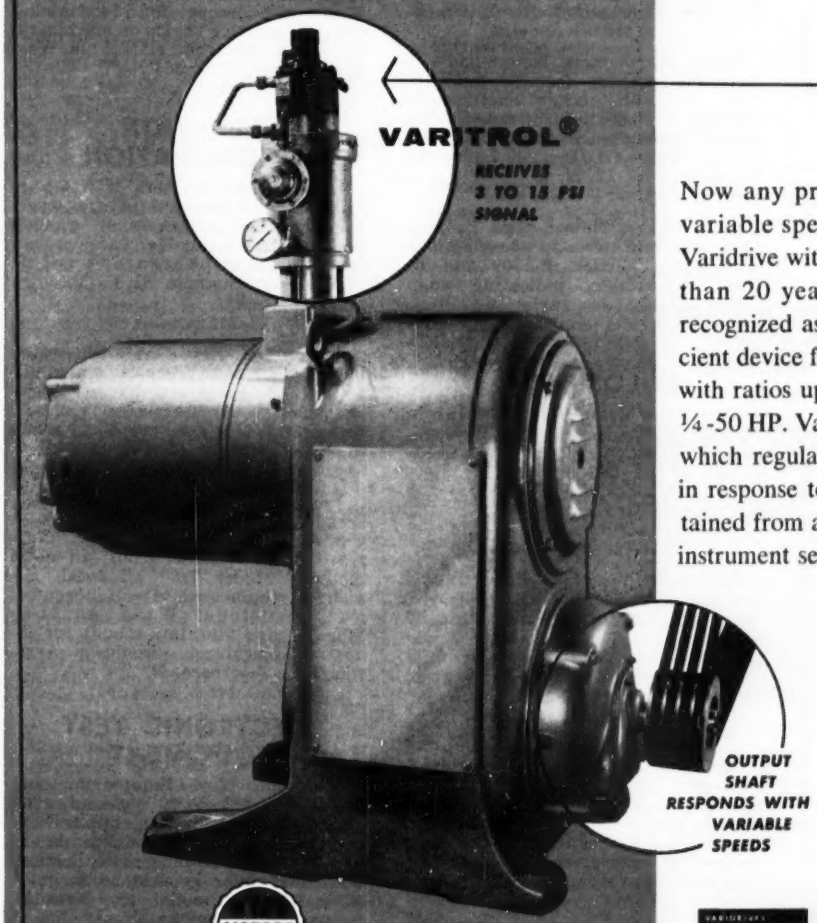
Circle **582** on inquiry card.

Gas Analysis. New 4-page illustrated brochure covers features, specifications, principle of operation and special applications of maker's universal thermal-conductivity gas analyzers.—Charles Englehard, Inc., 850 Passaic Ave., East Newark, N. J.

Circle **583** on inquiry card.

Infrared Spectrometer. New 6-page Brochure FD 8-654 presents operating features of maker's "Model 112" sin-

AUTOMATIC CONTROL OF VARIABLE SPEEDS



Now any process requiring automatic variable speeds can be driven by U. S. Varidrive with Varitrol control. For more than 20 years the Varidrive has been recognized as the most compact and efficient device for obtaining variable speeds, with ratios up to 10:1 and capacity from ¼-50 HP. Varitrol is a new control device which regulates the speed of a Varidrive in response to a signal. The signal is obtained from a standard type of pneumatic instrument sensitive to such variables as:

Temperatures	Liquid Level
Humidity	Weight
Pressure	Tension
Speed	Position

Many firms are increasing productivity with Varitrol control. Quality of product is improved, human effort is reduced. Lower costs result in better salability of your products.

U. S. Engineers are experienced in variable speed problems, and can help you apply Varidrives to your process.

MOTORS

¼ TO 50 HP

U.S. VARIDRIVE

THE MIRACLE MOTOR WITH VARITROL®

Request new Bulletin on Varidrives with Varitrol automatic control. Indicate if you would like additional literature on Varidrives.

REQUEST FOR VARITROL BULLETIN

U. S. ELECTRICAL MOTORS INC. IA-9
Box 2058, Los Angeles 54, Calif. or Milford, Conn.
☐ Send also 16-page 4-color Booklet on Varidrives

NAME_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE___ STATE_____

For more information circle **141** on inquiry card.

YOU SUPPLY THE PROBLEM!

We'll Supply the Answer

Through our SPECIAL Instrument Design and Complete Manufacturing Services

Many different firms in the following fields rely on these services to solve their most difficult problems:

- AERONAUTICAL
- INDUSTRIAL
- MEDICAL
- MARINE

Rodon, Inc., has the production equipment, the test equipment and the ability to solve your problem. So, don't file it away . . . give it to Rodon! Write, wire or call.

RODON, INC.
NESHAMINY, PA.
Phone: OSborne 5-6700

For more information circle **142** on inquiry card.

HARDNESS TESTING...

done WITH NO MENTAL HAZARDS. The SCLEROSCOPE has done it for the past 47 years.

In general use for specification purposes. Simple, sturdy Comparatively inexpensive.

Illustrated bulletins free

The Shore Instrument & Mfg. Co., Inc.
90-35 Van Wyck Expressway
Jamaica 35, N. Y.

For more information circle **143** on inquiry card.

NEW LITERATURE

gle-beam, double-pass, recording infrared spectrometer.—Perkin-Elmer Corp., Norwalk, Conn.

Circle **584** on inquiry card.

GAGING

Optical Comparator. New 8-page Catalog L-400 illustrates and describes maker's "Model L-400" horizontal bench-type optical comparator.—Portman Instrument Co., Town Dock Rd., New Rochelle, N. Y.

Circle **585** on inquiry card.

Air Gages. New 32-page Catalog 613 describes and illustrates maker's air gages, including components, application and operation.—Taft-Peirce Mfg. Co., Woonsocket, Rhode Island.

Circle **586** on inquiry card.

Bench Micrometers. New 2-page illustrated brochure describes maker's "40G and 40H" bench micrometers reading in 0.0001 inch directly on thimble graduated in 250 divisions.—George Scherr Co., Inc. 200 Lafayette St., New York 12, N. Y.

Circle **587** on inquiry card.

Snap Gages. New 6-page Catalog 54 E lists features and specifications of maker's "Models B-1200 and B-1300" adjustable, indicating snap gages.—Reliant Industries, 4947 Firestone Boulevard, South Gate, Calif.

Circle **588** on inquiry card.

BOLOMETERS

Thermistor Bolometers. New 2-page Bulletin ODC-413 presents features, uses, applications, description, specifications and diagrams of maker's "Type BC-1" infrared thermistor bolometer.—Olympic Development Co., 30 Commerce Rd., Stamford, Conn.

Circle **589** on inquiry card.

Bolometer Preamplifier. New 2-page Bulletin 23 presents applications, detailed description, dimensions, etc. of maker's "Model BA-1" bolometer preamplifier for r-f. measurements.—Weinschel Engineering, Kensington, Maryland.

Circle **590** on inquiry card.

MAGNETS

Magnet Applications. New 12-page issue of "Applied Magnetics" (Vol. 2 No. 4) features articles on use of magnets and magnetic devices to solve measuring problems.—Indiana Steel Products Co., Valparaiso, Ind.

Circle **591** on inquiry card.

TESTING

Magnetic-particle Tester. New 2-page reprint describes and illustrates maker's "Portaflux" magnetic-particle test unit.—Research & Control Instruments Div., North American Philips Co., Inc., 750 South Fulton Ave., Mount Vernon, N. Y.

Circle **592** on inquiry card.

Shielding Rooms. New 8-page illustrated brochure covers features, applications, designs, attenuation characteristics, maintenance and operation of maker's "Multi-Cell" shielding rooms for RF interference suppression.—Shielding, Inc., Riverside, N. J.

Circle **593** on inquiry card.

SPEED

Tachometers, Generators. New 24-page Catalog E1-1A covers maker's d-c. permanent-magnet tachometer, d-c. wound-field, a-c. permanent-magnet and a-c. sine-wave generators.—Electric Indicator Co., Inc., Springdale, Conn.

Circle **594** on inquiry card.

Hand Tachometers. New 4-page Bulletin 103 pictures and describes maker's "3-in-1" hand tachometers featuring three ranges in one instrument.—Metron Instrument Co., 432 Lincoln St., Denver 3, Colo.

Circle **595** on inquiry card.

Stroboscope. New 2-page illustrated brochure presents description and specifications of maker's "Model A-44" stroboscope for determining rpm. of revolving shafts on machinery, etc.—Sela Electronics Co., 128 West 48 St., New York 36, N. Y.

Circle **596** on inquiry card.

VIBRATION, ACCELERATION

Linear Accelerometers. New 4-page Bulletin AT-1 presents features, specifications and diagrams of maker's temperature-controlled accelerometers.—Statham Laboratories, Inc., 12401 West Olympic Blvd., Los Angeles 64, Calif.

Circle **597** on inquiry card.

Vibrograph. New 2-page illustrated brochure presents features, and applications of maker's universal vibrograph for measuring vibrations and accelerations.—Epic Inc., 154 Nassau St., New York 38, N. Y.

Circle **598** on inquiry card.

Vibration, Shock Control. Four new 2-page issues of "Vibration and Shock Control Trends" describe and illustrate maker's "Model K130" all-metal mount; "Model 728" all-metal, all-attitude engineered vibration control system; "Model W139 Adjust-O-Mount"; and vibration mount for industrial machinery.—Robinson Aviation Inc., Teterboro, N. J.

Circle **599** on inquiry card.

ELECTRONIC TEST EQUIPMENT

Electronic Test Equipment. New 64-page Catalog "D" covers complete engineering data, applications and specifications of standard and television signal generators, square-wave and pulse generators, megacycle meters, voltmeters, etc.—Measurements Corp., Boonton, N. J.

Circle **600** on inquiry card.

Magnetic DC Amplifier. New 4-page Engineering Bulletin EB-201 describes and illustrates maker's "Micromag" low-level magnetic-type low-level signal amplifier.—Magnetic Research Corp., 200-202 Center St., El Segundo, Calif.

Circle **601** on inquiry card.

Wave Analyzer. New 10-page Bulletin 54-C illustrates and describes maker's heterodyne-type, automatic wave analyzer for fourier analysis of vibration and similar data.—Davies Laboratories Inc., 4705 Queensbury Rd., Riverdale, Md.

Circle **602** on inquiry card.

Bridges, Ratio Sets. New Data Sheet Group E-53 describes maker's bridges, slidewires and ratio sets for d-c. and conductance measurements. —Leeds & Northrup Co., 4934 Stenton Ave., Phila. 44, Pa.

Circle **603** on inquiry card.

Impedance Bridge. New 4-page illustrated brochure lists features and specifications of maker's "Model 100-B" vector impedance bridge.—Republic Engineering Co., Inc., Beltsville, Md.

Circle **604** on inquiry card.

AC Voltmeters. New 4-page illustrated Brochure B-205 describes maker's "Models MV-12B, MV-22B and MV-18C" vacuum-tube, a-c. voltmeters for use from 20 cps. to 2500 Mc. —Millivac Instrument Corp., P. O. Box 997, Schenectady, N. Y.

Circle **605** on inquiry card.

VT Voltmeter. New 4-page issue of "hp Journal" (Vol. 5 No. 9) features article on maker's new wide-range and high-stability vacuum-tube voltmeter for 10 cps. to 4 Mc.—Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.

Circle **606** on inquiry card.

Voltage Calibrator. New 2-page illustrated brochure presents description and specifications of maker's "Model TG-2" precision voltage calibrator for use with oscilloscopes or oscillographs.—G. W. Associates, P. O. Box 2263, El Segundo, Calif.

Circle **607** on inquiry card.

Signal Generators. New 2-page Bulletins 755 and 710 describe and illustrate maker's "Model 755" noise generator and "Model 710" sine-square wave generator. 4-page Bulletin 8A describes and illustrates video generator, sweep-alignment generator, VTVM's etc.—Hickock Electrical Instrument Co., 10514 Dupont Ave., Cleveland 8, Ohio.

Circle **608** on inquiry card.

Oscilloscopes, Tube Testers. New 4-page Bulletin 8B describes and illustrates maker's oscilloscopes and tube testers.—Hickock Electrical Instrument Co., 10514 Dupont Ave., Cleveland 8, Ohio.

Circle **609** on inquiry card.

Electronic Generators. New 16-page 1954 catalog presents description and illustrations of maker's electronic generators; also regulated power supply, test plugs, cables, stroboscope, megohm meter, vacuum-tube voltmeter, delay-line packages, printed-circuit packages, etc.—Communication Measurements Laboratory, Inc., 350 Leland Ave., Plainfield, N. J.

Circle **610** on inquiry card.

Sound Probe. New 4-page Bulletin N-93 describes and illustrates maker's electronic sound probe for locating hidden mechanical troubles.—Gei-Me Co., P. O. Box 293, Bloomington, Ill.

Circle **611** on inquiry card.

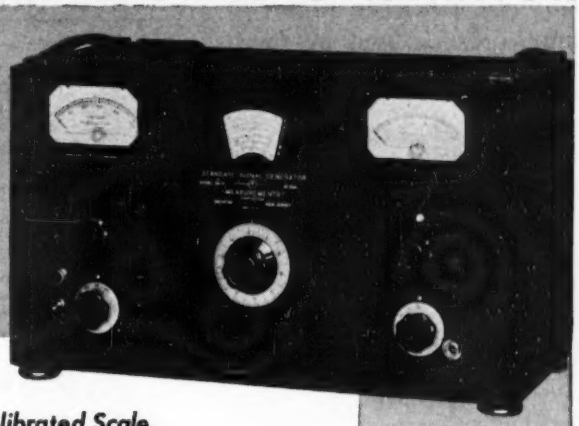
Audio Generator. New 8-page issue of the "General Radio Experimenter" (Vol. 24 No. 1) features article describing maker's "Type 1304-B" beat-frequency audio generator.—General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

Circle **612** on inquiry card.

STANDARD SIGNAL GENERATOR

MODEL 65-B

RANGE 75 KC to 30 MC



Individually Calibrated Scale

OUTPUT: Continuously variable, .1 microvolt to 2.2 volts.
OUTPUT IMPEDANCE: 5 ohms to .2 volt, rising to 15 ohms at 2.2 volts.
MODULATION: From zero to 100%. 400 cycles, 1000 cycles and provision for external modulation. Built-in, low distortion modulating amplifier.
POWER SUPPLY: 117 volts, 50-60 cycles, AC.
DIMENSIONS: 11" high, 20" long, 10¼" deep, overall.
WEIGHT: Approximately 50 lbs.

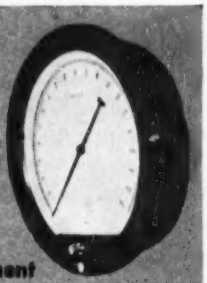
Catalog on request

MEASUREMENTS CORPORATION
BOONTON NEW JERSEY

MANUFACTURERS OF
Standard Signal Generators
Pulse Generators
FM Signal Generators
Square Wave Generators
Vacuum Tube Voltmeters
UHF Radio Noise & Field Strength Meters
Capacity Bridges
Megohm Meters
Phase Sequence Indicators
Television and FM Test Equipment

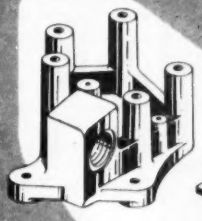
For more information circle **144** on inquiry card.

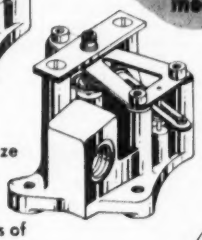
HEISE GAUGES



Precision Built

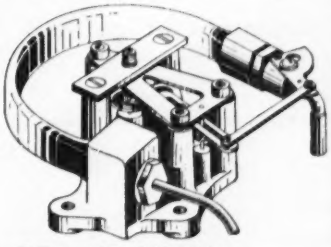
For laboratory service The scientifically accurate pressure measuring instrument





★ Permanent positive accuracy of alignment guaranteed by integral construction.
★ Weldless heat treated Bourdon tube maintains precise calibration.
★ Patented "External Bleeder"

★ Massive Bronze casting coordinates all working parts of the gauge



Pressure ranges 15 to 20,000 psi.
Sizes 8½", 12" and 16"
Prices from $151.60

CATALOG ON REQUEST

THE STANDARD OF THE WORLD

HEISE BOURDON TUBE COMPANY, INC.
BROOK ROAD, NEWTOWN, CONNECTICUT, U.S.A.

For more information circle **145** on inquiry card.

Announcing—the first and much-needed book on small research reactors

Nuclear Reactors for Industry and Universities

written by eight eminent authorities and edited by Ernest H. Wakefield

CONTENTS

Chapter I. Nuclear Reactor Types
Chapter II. Availability and Selection
Chapter III. Radioactivity Measurement
Chapter IV. Radiation Protection
Chapter V. Reactor Control
Chapter VI. Instruments for Experiments
Chapter VII. Cost Study
Chapter VIII. Legal Aspects

APPENDIX—Glossary of Terminology, Cloth, 102 pages, photos and diagrams, 4-page index.

$2.00 postpaid

Remittance must accompany order

Instruments Publishing Company
845 Ridge Avenue,
Pittsburgh 12, Pennsylvania

Enclosed is ..... for ..... copies of Wakefield's Nuclear Reactors book at $2.00 each, postpaid.

Name .....

Address .....

City .....

NEW LITERATURE

Electrometer. New 4-page illustrated Brochure 10M554 covers description, applications, construction and specifications of maker's "Model 210" electrometer.—Keithley Instruments, 3868 Carnegie Ave., Cleveland 15, Ohio.

Circle **613** on inquiry card.

Insulation Tester. New 24-page Bulletin 21-2089 describes and illustrates maker's high-range "Megger" insulation resistance testers that are rectifier operated.—James G. Biddle Co., 1316 Arch St., Phila. 7, Penna.

Circle **614** on inquiry card.

RF INSTRUMENTS

VHF Interpolator. New 2-page bulletin covers specifications and performance characteristics of maker's "Model AM-1" VHF interpolator for precise generation and measurement of any signal from 20 to 1000 Mc.—Gertsch Products, Inc., 11846-48 Mississippi Ave., Los Angeles 25, Calif.

Circle **615** on inquiry card.

Frequency Meter. New 2-page bulletin presents specifications and applications of maker's "Model TS-175 A/U" frequency meter for 85 to 1000 Mc.—Colortone Electronics, Inc., 238 William St., New York, N. Y.

Circle **616** on inquiry card.

HF Generator. New 2-page Bulletin G-554 describes and illustrates maker's convertable "Ectrotherm" high-frequency generator for plastic welding and packaging machinery.—Electronic Processes Corp., 1136 San Antonio Rd., Los Altos, Calif.

Circle **617** on inquiry card.

Attenuators. New 2-page brochure pictures and presents characteristics of maker's "Models HFA-75 and HFA-50" fixed-pad attenuators for 0-1000 Mc. frequency range.—Applied Research Inc., 163-07 Deport Road, Flushing, N. Y.

Circle **618** on inquiry card.

Waveguide Components. New 4-page Catalog X-3 describes and pictures maker's X-band waveguide components and test equipment.—Transline Associates, 57 State St., Newark, N. J.

Circle **619** on inquiry card.

ELECTRICAL INDICATORS

Reference-standard DC Instruments. New 4-page issue of "Electrical Measurements" (Vol. 21, No. 7) describes maker's reference-standard "Poly-Ranger" with 14 ranges in voltage and current in two combinations.—Sensitive Research Instrument Corp., Mount Vernon, N. Y.

Circle **620** on inquiry card.

Electrical Indicators. New 4-page Bulletin IPLM 353 describes and illustrates maker's milliammeters, ammeters, voltmeters, wattmeters, etc. for panels, aircraft, portable applications. 2-page Bulletin 235 754H describes and illustrates maker's portable field-strength meter.—Hickock Electrical Instrument Co., 10514 Dupont Ave., Cleveland 8, Ohio.

Circle **621** on inquiry card.

POWER SUPPLIES

Power Supply. New 4-page issue of the "hp Journal" (Vol. 5 No. 10) features article on maker's new "Model 712B" 500-volt, 200-ma. metered power supply.—Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.

Circle **622** on inquiry card.

Power Supplies. New 2-page illustrated brochure presents specifications of maker's "Model 1" electronically-regulated d-c., constant-voltage power supplies.—Associated Specialties Co., 1751 Main St., Orefield, Pa.

Circle **623** on inquiry card.

Line-Voltage Regulator. New 8-page issue of the "General Radio Experimenter" (Vol. 29 No. 2) presents articles on maker's automatic line-voltage regulator and "Variac" autotransformers.—General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

Circle **624** on inquiry card.

RESISTORS, POTENTIOMETERS

Resistance Strips. New 4-page Bulletin T-1 presents charts, graphs and data on construction, tolerances, resistance values, power and voltage ratings, dimensions, machining technique, etc. of maker's resistance strips and concentric-disc resistors.—International Resistance Co., 401 North Broad St., Phila. 8, Pa.

Circle **625** on inquiry card.

High-frequency Resistors. New 2-page Bulletin F-3 covers applications, specifications, characteristics and dimensions of maker's "Type HFR" high-frequency miniature resistors.—International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.

Circle **626** on inquiry card.

Encapsulated Resistors. New 2-page Bulletin 145 presents description, tolerances and dimensions of maker's new "Type 85 and 86 Riteohm" completely encapsulated precision resistors.—Ohmite Mfg. Co., 3601 Howard St., Skokie, Ill.

Circle **627** on inquiry card.

Wirewound Resistors. New 2-page bulletin describes maker's "Cal-Ohm Type EM" encapsulated miniature, precision wirewound resistors.—Eastman Pacific Co., 2320 East 8th St., Los Angeles 21, Calif.

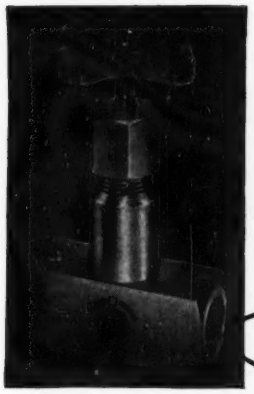
Circle **628** on inquiry card.

Rotational Potentiometer. New 2-page Bulletin B 53 presents features, applications, performance characteristics, and specifications of maker's "Type 2094" rotational potentiometer.—Markite Corp., 155 Waverly Place, New York 14, N. Y.

Circle **629** on inquiry card.

Computer Potentiometers. New 12-page Technical Paper 341 "Characteristics of Pecision Servo Computer Potentiometers" discusses linearity and presents data on research, development and trends in precision potentiometers.—Helipot Corp., South Pasadena, Calif.

Circle **630** on inquiry card.

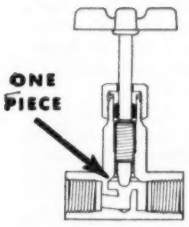


New MARSH Needle Valves

MAXIMUM WORKING PRESSURE 10,000 PSI

. . . for finer regulation of water, oil or gas

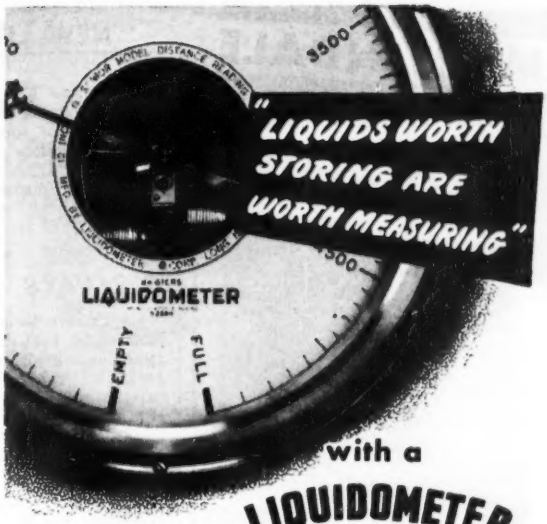
First needle valve to combine all the characteristics called for in modern industry. Embodies sturdiest basic construction—machined from solid bar stock—suitable for pressures to 10,000 psi and equally efficient in lower range. Note stem guide fused to body by new "Conoweld" process, eliminating faults of conventional two-piece valves. Stem 416 stainless steel. Stem threads fine pitch for strength and micrometer regulation. Body electro-zinc plated. Sizes ⅛" to 1", globe and angle patterns.



Ask for new Needle Valve Catalog

MARSH INSTRUMENT CO. *Sales affiliate of Jas. P. Marsh Corporation*
Dept. 42, Skokie, Ill.

For more information circle **146** on inquiry card.



with a **LIQUIDOMETER** *Tank Gauge*

- FOR GAUGING LIQUIDS OF ALL KINDS
- 100% AUTOMATIC
- APPROVED BY UNDERWRITERS' LABORATORIES

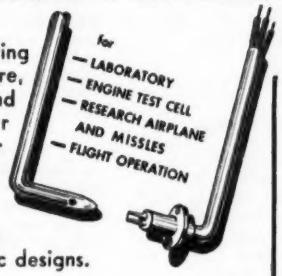
WRITE FOR COMPLETE DETAILS

THE LIQUIDOMETER CORP.
36-27 SKILLMAN AVE., LONG ISLAND CITY, N.Y.

For more information circle **148** on inquiry card.

AERODYNAMIC PROBES

- Designing and fabricating thermocouples, pressure, velocity, direction and hot wire anemometer probes to solve your flow measuring problems.



- Accurately fabricating probes to your specific designs.
- Aerodynamic Calibrations for all probes obtained in our own wind funnel.
- Designing complete temperature and pressure measuring systems for your test rigs.
- Production facilities for manufacturing large quantities of thermocouple probes for the operational engine.
- Complete Hot Wire Anemometer Systems.

DESIGN, SPECIAL FABRICATION, PRODUCTION, CONSULTATION for TURBO JET —RAM JET—ROCKET—COMPONENT INSTRUMENTATION

Our engineering staff is familiar with problems in fluid flow measurement. For further information write to

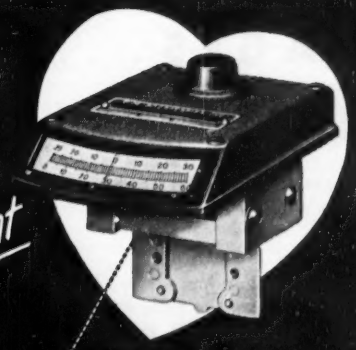
aero research INSTRUMENT COMPANY, INC.
1901 NORTH HERMITAGE AVENUE CHICAGO 22, ILLINOIS

For more information circle **147** on inquiry card.

Make a GM PORTABLE D'ARSONVAL

GALVANOMETER

the Heart of Your Instrument



FOR MEASURING LIGHT reflectance and color, the Photovolt Corporation of New York uses a Model 600 G-M Galvanometer for its popular Reflection Meter (left). Whatever your own particular instrument field, you can achieve this same self-contained portability, ruggedness and high sensitivity with G-M Galvanometers. Complete catalog on request.

GM LABORATORIES · INC.
4316 NORTH KNOX AVE., CHICAGO 41

In Canada: Cossor (Canada) Ltd., 301 Windsor St., Halifax, N. S.

For more information circle **149** on inquiry card.

MARTINDALE

MODEL 52 V.A.O. TESTER

This new, sturdy, portable instrument has 5" meter—Four testing ranges: Volts, AC and DC: 0-2.5-0, 10-0-50, 0-250, 0-1000. Amperes; DC only: 0-10: Ohms: 0-1000, 0-10000; Megohms: 0-1, 0-100. Selector Switch provides four positions: Volts AC, Volts DC, Ohms, Amps. Range Switch has 5 positions which provide for above Voltage ranges, 4 ohm ranges, and 1 ampere range. 4' test leads have both prods and alligator clips. Has sturdy, Neolite carrying case.

Write for 64-Page Catalog No. 29 describing many products for industrial Maintenance, Safety and Production.

MARTINDALE ELECTRIC CO.

1360 Hird Avenue, Cleveland 7, Ohio

For more information circle **150** on inquiry card.

Fine

PRESSURE GAGES . . .

Fine pressure gages should also be safe gages.

Gages so built that in case of tube rupture no one will be injured.

The Acragage has always been the safe gage, the gage with the solid front and full area blow-out disc.

Catalog M-50 tells more about the safe ACRAGAGE.

Send for your copy today.

***The* ACRAGAGE**

Corporation

WAMPUS LANE • MILFORD, CONN.

For more information circle **151** on inquiry card.

NEW LITERATURE

Resistors. New 2-page illustrated bulletin lists characteristics and specifications of maker's new "Rhom-Ized" precision wirewound resistors for use under every climatic condition.—Rho Engineering Co., 4205 Sepulveda Blvd., Culver City, Calif.

Circle **631** on inquiry card.

RELAYS, SWITCHES

Capacitive Relays. New 4-page bulletin lists features, applications and specifications of maker's new "Capaswitch" relay with electrostrictive capacitive unit.—Mullenbach Electrical Mfg. Co., P. O. Box 15436, East 27 St., Los Angeles 58, Calif.

Circle **632** on inquiry card.

Time-delay Relays. New 2-page Bulletin A. W. H. TD400 presents description, design features, diagrams and photographs of maker's "6400, 11400, 24300 Series" miniature hermetically-sealed time-delay relays.—A. W. Haydon Co., Waterbury, Conn.

Circle **633** on inquiry card.

Solenoids. New 2-page illustrated Bulletin PR-S2 presents dimensional sketch, characteristics chart and description of maker's "Nos. 20287 and 20288" miniature d-c. solenoids.—Cannon Electric Co., 3209 Humboldt Ave., Los Angeles 31, Calif.

Circle **634** on inquiry card.

Switches. New 16-page Bulletin RC-9B presents description, specifications and diagrams of maker's line and slide switches.—Electronic Components Div., Stackpole Carbon Co., St. Marys, Pa.

Circle **635** on inquiry card.

Computer, Miniature Relays. New 12-page brochure presents maker's line of "Series 100" computer relays, "Series 300" miniature relays, "Series 400" coaxial relays, and "Series 500" communication relays. Includes specifications, installation and performance data.—Joseph Pollack Corp., 81 Freeport Rd., Boston 22, Mass.

Circle **636** on inquiry card.

Relays, Actuators. New 48-page catalog illustrates and describes maker's actuators, and multi-contact, power, and hermetically sealed relays.—Phillips Control Corp., Joliet, Ill.

Circle **637** on inquiry card.

ELECTRONIC COMPONENTS

Transistors. Two new 2-page bulletins present mechanical and electrical data, and application for maker's "Type 700" tetrode transistor and "Type 800" phototransistor.—Texas Instruments Inc., 6000 Lemmon Ave., Dallas 9, Tex.

Circle **638** on inquiry card.

Printed Circuits. New 12-page Bulletin 475 "Formica Copper-Clad for Better Printed Circuits" discusses printed circuitary and advantages and applications of copper-surfaced laminated plastics.—Formica Co., 4614 Spring Grove Ave., Cincinnati 25, Ohio.

Circle **639** on inquiry card.

Connectors. New 2-page bulletin includes schematics, mechanical and electrical ratings of maker's high-voltage six-contact connectors "FHL-6."—DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle **640** on inquiry card.

Transformers. New 32-page Catalog CT-554 describes and illustrates maker's "Sealed-in-Steel" transformers. Covers over 500 stock transformers for military, new equipment, general replacement and power and control applications.—Chicago Standard Transformer Corp., 3501 Addison St., Chicago 18, Ill.

Circle **641** on inquiry card.

Toroid Inductors. New 2-page bulletin covers uses, description, features and specifications of maker's "Ferroxcube 3C" core, toroid inductors.—Mico Instrument Co., 86 Trowbridge St., Cambridge 38, Mass.

Circle **642** on inquiry card.

Toroid Coils. New 2-page Bulletin PR pictures and describes maker's toroid coils adjustable to within plus or minus 5 percent of nominal inductance valves.—Hycor Co., Inc., Vega Baja, Puerto Rico.

Circle **643** on inquiry card.

Network Board. New 2-page bulletin pictures and describes maker's "Model P100 network board which provides, on one panel, facilities for rapid connection and evaluation of developmental R-C circuits.—Instrument Research Co., 371 Harvard St., Cambridge 38, Mass.

Circle **644** on inquiry card.

Transformers. New 4-page illustrated brochure presents description, mechanical and electrical specifications and applications of maker's "PT-Series" standard ratio transformer, a precision autotransformer capable of extreme accuracy and resolution in measurement and generation of a-c. voltage ratios. Gertsch Products, Inc., 11846-48 Mississippi Ave., Los Angeles 25, Calif.

Circle **645** on inquiry card.

Transformers, Electrical Equipment. New 36-page issue of "Electrical Review" (Vol. 19 No. 2) presents articles on wind-tunnel drive control, generator control, power-transformer selection, etc.—Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.

Circle **646** on inquiry card.

AIR, STEAM

Compressed Air Cleaner. New 4-page Bulletin DA describes and pictures maker's "DriAir" self-contained, automatic compressed-air separator unit for filtering and cleaning air.—New Jersey Meter Co., Plainfield, N. J.

Circle **647** on inquiry card.

Designed for portability and low-cost as well as accuracy, the newly developed DS-660 will count and display any electrical or mechanical event which can be converted into a varying voltage of sufficient amptitude — from 10 to 100,000 events per second. Derives its time base from the 60 cycle line — which determines the accuracy — approximately .1%. Here is new and amazing reliability and circuitry available in one unit.

FEATURES:

SELF CHECKING

AUTOMATIC and MANUAL RESET

DISPLAY from 1 to 10 SECONDS

LIGHTWEIGHT — only 16 lbs.

UTILIZES STANDARD PLUG-IN DECADES

BASIC UNIT READS OUT TO 10 KC (4 decades)

AIR COOLED (Fan)

Write TODAY for full technical information

THE Detectron CORPORATION, Dept. 80-A

5420 VINELAND AVE., NO. HOLLYWOOD, CALIF.

For more information circle **152** on inquiry card.

How's your technical library? Check this list.

Electronic circuitry for Instruments and Equipment by Milton H. Aronson, 1953, cloth, 310 pages. Price $4.00 ☐

Scientific and Industrial Glass Blowing and Laboratory Techniques by W. E. Barr and Victor J. Anhorn, 1949, cloth, 4½" x 8", 388 pages. Price $6.00 ☐

The Electronic Control Handbook by R. R. Batcher & Wm. Moulic, 1952, paper, 244 pages. Price $3.00 ☐

Heat Inertia Problems of Automatic Control of Temperature by Victor Broida, 1950, paper, 5¼" x 8¼", 61 pages. Price $1.00 ☐

Applications of Industrial pH Controls by Allen L. Chaplin, 1950, cloth, 4½" x 8", 144 pages. Price $2.50 ☐

Maintenance and Servicing of Electrical Instruments by James Spencer, Third Edition 1951, cloth, 4¾" x 8¼", 256 pages. Price $3.00 ☐

Mechanical Measurements by Electrical Methods by Howard C. Roberts, Second Edition 1951, cloth, 4¾" x 8¼", 357 pages. Price $4.00 ☐

(Payment must accompany order)

Instruments Publishing Company
845 Ridge Avenue,
Pittsburgh 12, Pennsylvania

Enclosed is $..... for ..... copies of .....

Name .....

Address .....

City .....

D-C AMPLIFIER

Model 14
Ultra Sensitive

Lowest Noise Level

Highest Zero Stability

of any commercially available breaker-type D-C Amplifier

Model 14 is an electronic Amplifier capable of replacing suspension galvanometers. Its simplicity, light weight, and resistance to vibrations are especially attractive features. Present uses cover such diverse fields as measuring nerve voltages, optical pyrometry, precision calorimetry, and as a null indicator on super-sensitive Mueller bridges without the need for additional bridge shielding.

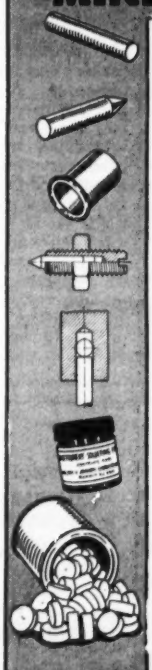
Consult our engineers on your problems which require electronic measurements of the highest accuracy, maximum sensitivity, and exceptional dependability.

Foremost manufacturer of Infra-Red Gas Analyzers

LISTON-BECKER
INSTRUMENT COMPANY, Inc.
653-C HOPE STREET
STAMFORD • CONNECTICUT

For more information circle **153** on inquiry card.

MINIATURE PARTS



CUSTOM MANUFACTURE OF SMALL PARTS

• Shafts, Staffs and Pivots of Special Pivot Steel, Heat-Treated and Metallographic-Polished. • Tubular Products up to ⅜" Diameter, Cut, Flared, Swaged, Formed and Burr-Free Alloy or Silver Plated. • Screw-Machine Products up to 3/16" Diameter. • Roll-Threading and Knurling to Close Tolerances. • Centerless and Surface Grinding with Special Facilities for Ceramic Rods and Shapes. • Light Punch-Press Work.

SERVICES FOR CUSTOMERS' PARTS

• A Multitude of Services are Available for Customers' Parts at Any Stage of Manufacture. These Include: Controlled-Atmosphere Heat-Treating, Centerless Grinding, Surface Grinding, Knurling, Thread-Rolling, Swaging, Drilling, Milling, Burr Removing, Metallographic, Polishing, Barrel-Plating in Alloy or Silver.

ASSEMBLY SUPPLIES

• "Welton" Non-Corrosive Instrument Solder Paste. • "Weltonoil" Treated Buttonwood Pith.

APPARATUS DESIGN SERVICES

In Connection with the Design and Fabrication of Precision Miniature Parts.

ENGINEERING ASSISTANCE ON ALL ITEMS

Welton V. Johnson
ENGINEERING COMPANY INC.
87 SUMMIT AVENUE • SUMMIT, N. J.

For more information circle **154** on inquiry card.

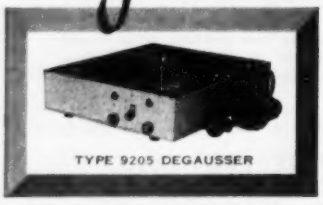
SEARCHLITE SECTION

CLASSIFIED ADVERTISING
EMPLOYMENT & BUSINESS OPPORTUNITIES

The advertising rate is $12.00 per inch for all advertising (An advertising inch is measured ⅞ inch vertically by 2⅛ inches wide.)

Send advertisements to INSTRUMENTS & AUTOMATION, 845 Ridge Ave., Pittsburgh 12, Pa.

CINEMA'S
TAPE AND FILM
Degausser
CLEAN ERASURE OF MAGNETIC TAPE & FILM



Noise & program erasure. Use the best. Cinema's Bulk-Tank Type Degausser 9205. Economically priced. Buy yours today.

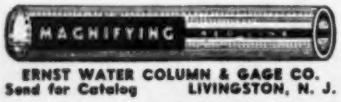
CINEMA ENGINEERING CO.
DIVISION AEROVOX CORPORATION
1100 CHESTNUT STREET • BURBANK CALIF.

For more information circle **155** on inquiry card.

SCIENTISTS-ENGINEERS

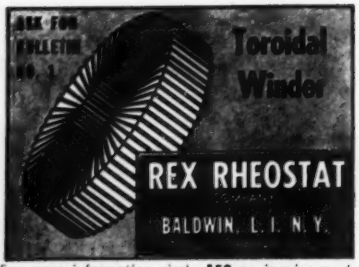
The new Research and Development Laboratories at our Anaheim, California Division provide opportunities for creative work in aircraft and missile guidance and controls. Engineers, Physicists, and Metallurgists with proven experience and Assistants with superior educational records are needed. Our company has a long history of successful, research, development, and manufacturing of precision control devices. Permanent employment and recognition of high quality workmanship are cornerstones of company policy. Address inquiries to: Director of Research and Development, Robertshaw-Fulton Controls Company, Anaheim, California.

GAGE GLASSES AND
High Pressure Rubber Gaskets
ALL SIZES TO FIT YOUR GAGES & VALVES

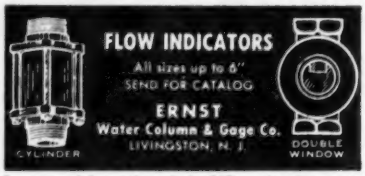


ERNST WATER COLUMN & GAGE CO.
Send for Catalog LIVINGSTON, N. J.

For more information circle **157** on inquiry card.



For more information circle **158** on inquiry card.



For more information circle **159** on inquiry card.

INSTRUMENT MECHANICS WANTED

The Tennessee Valley Authority wants experienced instrument mechanics for work in chemical plants at Wilson Dam, Alabama. The work is inspecting, testing, repairing, adjusting, and calibrating service instruments, including actuating connections and control equipment. Instruments are electricial, mechanical, pneumatic, hydraulic, thermal, or any combination of these. Salary is $4712 per year for 40-hour week. Liberal vacation leave, sick leave, and retirement benefits.

Write to the
TENNESSEE VALLEY AUTHORITY
Division of Personnel
Knoxville, Tennessee

SALES REPRESENTATIVES

Established manufacturer of laboratory and industrial glass thermometers, dial indicating and recording thermometers, and vacuum and pressure gauges and recorders interested in obtaining additional sales representation. Extremely diversified line permits full coverage in the temperature and pressure field. Good territories open for qualified agents on an exclusive protected basis. Openings available in fourteen states. Advise fully, stating territory covered. Box 272, Instruments Publishing Company, 845 Ridge Avenue, Pittsburgh 12, Penna.

"As a comprehensive source book on instrument circuitry, this one will be hard to beat" . . . *Radio & Television News* (Sept. 1953)

ELECTRONIC CIRCUITRY FOR INSTRUMENTS & EQUIPMENT

By MILTON H. ARONSON
Technical Editor, *Instruments*

Instruments Publishing Company
845 Ridge Avenue
Pittsburgh 12, Pennsylvania

Enclosed is $..... for ..... copies of Aronson's ELECTRONIC CIRCUITRY BOOK at $4.00 each, postpaid.

Name .....
Address .....
City .....

Steam Generator. New 2-page illustrated brochure lists features and applications of maker's "Hot Shot" electric steam generator.—Sussman Automatic Steam Products Corp., 140 West 31 St., New York 1, N. Y.

Circle **648** on inquiry card.

Steam Turbines. New 22-page Reprint 03R8145 "Steam Turbine History Highlights" traces progress in steam turbine development from first applications to present time.—Allis Chalmers Mfg. Co., 942 S. 70 St., Milwaukee, Wis.

Circle **649** on inquiry card.

BEARINGS

Jewel Bearings, Parts. New 8-page catalog discusses maker's jewel bearings, and art of jewel setting. Presents maker's screw machine parts and turned parts.—Instrument Products Corp., 136 Liberty St., New York 6, N. Y.

Circle **650** on inquiry card.

Bearings, New 8-page illustrated Catalog 206 presents description and applications of maker's "Nylined" nylon-plastic-lined bearings for rotation and reciprocation.—Thomson Industries, Inc., Manhasset, Mass.

Circle **651** on inquiry card.

MATERIALS

Wire, Foils, Ribbons. New 4-page brochure describes maker's thin foils; metallic ribbons; and bare drawn, Wollaston, Taylor process, and extruded-resistance and potentiometer wires.—Baker & Co., Inc., 113 Astor St., Newark 5, N. J.

Circle **652** on inquiry card.

Copper-clad Plastic Laminates. New 4-page bulletin covers "Grades T-725 and T-812" copper-clad "Insurok" laminates for use in printed circuits. —Richardson Co., 2661 Lake St., Melrose Park, Ill.

Circle **653** on inquiry card.

Bore Tubing. New 4-page illustrated Bulletin 100 lists in tabular form sizes of maker's precision-bore capillary tubing.—Wilmad Glass Co., Franklin & Flower Sts., Landisville, N. J.

Circle **654** on inquiry card.

FABRICATION

Soldering Irons. New 8-page Bulletin GEA-4519D describes and illustrates maker's industrial soldering irons equipped with "Calrod" heaters. —General Electric Co., Schenectady 5, N. Y.

Circle **655** on inquiry card.

Screw Drivers. New 2-page brochure describes and pictures maker's precision-made screw drivers for work on watches and instruments.—Louis Levin & Son, Inc., 3610 South Broadway, Los Angeles 8, Calif.

Circle **656** on inquiry card.

Solder. New 80-page book "Solder . . . its fundamentals and usage" is scientific study of industrial applica-

tion and usage. Includes charts, tables and photographs.—Kester Solder Co., Dept. TP, 4201 Wrightwood Ave., Chicago 39, Ill.

Circle **657** on inquiry card.

Marking Machines. New 8-page catalog pictures and describes hand-operated, semi-automatic motorized and fully automatic machines for direct printing onto tubes, lamps, electronic components, textiles, etc.—Popper & Sons, Inc. 300 Fourth Ave., N. Y. 10, N. Y.

Circle **658** on inquiry card.

Drill Head. New 2-page illustrated bulletin lists features and specifications of maker's "Model AH-5" precision high-speed drilling head.—Telematic Corp., 3337 Robertson Boulevard, Los Angeles 34, Calif.

Circle **659** on inquiry card.

Copying Lathe. New 2-page bulletin pictures and describes maker's "Pilot" completely automatic, high-speed hydraulic copying lathe.—H. E. B. Machine Tools, Inc., 475 Fifth Ave., New York 17, N. Y.

Circle **660** on inquiry card.

Hopper Rack. New 2-page illustrated Bulletin HR-101 presents description, applications and specifications of maker's "NesTier" hopper racks for small parts.—Chas. Wm. Doepke Mfg. Co., Inc., Rossmoyne, Ohio.

Circle **661** on inquiry card.

MISCELLANEOUS

Industrial Training. New 24-page illustrated booklet "The Training Job and How to Meet It" appraises ways that correspondence education can be adapted to meet business and industrial training problems.—International Correspondence Schools, Scranton 9, Pa.

Circle **662** on inquiry card.

MANUFACTURING FACILITIES

Precision Instrument. New 10-page bulletin covers maker's history, personnel and plant facilities for producing highly technical laboratory and process control apparatus. Includes list of products manufactured (oscilloscopes, power supplies, annunciators, strain gages, optical comparators, gear trains, magnetometers, etc.)—Sunshine Scientific Instrument, 1810 Grant Ave., Phila. 15, Pa.

Circle **663** on inquiry card.

Fluorescent Lighting. New 24-page "Fluorescent Lighting Guide Book" is non-technical reference digest for buyers and sellers of fluorescent products. Discusses what fluorescent lighting is, its advantages, sizes available, colors, necessary accessories, etc.—Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.

Circle **664** on inquiry card.

Ultra Applicator. New 4-page illustrated Bulletin 155 presents uses, advantages, description and operation of maker's ultra applicator for laying down wet films of any desired thickness.—Gardner Laboratory, Inc., Bethesda 14, Md.

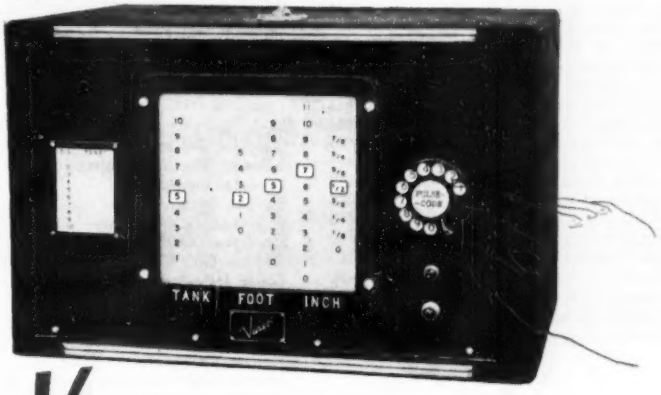
Circle **665** on inquiry card.

SCALE OF MILES

0 10 20 30 40 50 100

. . . accurate liquid level gauging-

at ANY DISTANCE!



"Varec"

SEE PULSE CODE AT THE INSTRUMENTS SHOW IN PHILADELPHIA, SEPT. 15-21 BOOTHS: 757, 759, 761

PULSE CODE

TELEMETERING SYSTEM

(PATENTS APPLIED FOR)

THE VAPOR RECOVERY SYSTEMS COMPANY has successfully eliminated the one great drawback to accurate transmission of remote tank gauging over long distances – *loss or gain of a part of the signal.*

Through use of the pulse code method of message transmission the system utilizes a separate pre-arranged code for each 1/8" increment of measurement.

At the receiver, the code transmitted by the tank unit is translated into the equivalent measurements – there can be no borderline cases where the reading might fall between two increments. The receiver will either produce the *correct* reading as transmitted *or it will not produce any reading.*

Obviously such an exact system is not confined to liquid level telemetering alone. It can be readily applied to numerous supervisory control problems such as remote control of pump motors, control valves and associated equipment. Thus the complete dispatching operation, gauging and remote control is integrated into one single unitized system when a "Varec" Pulse Code Telemetering System is installed.

The equipment is also capable of providing tank liquid level alarms or warnings of any off-normal conditions at the remote control point. Further, the receiver readings may be fed into automatic printing equipment for a permanent record and automatic sequencing equipment may be added to provide fully automatic tank gauging.

Before you install any type of remote gauging we urge you to thoroughly investigate the "Varec" Pulse Code Telemetering System – write today for complete details.

"Varec"

THE VAPOR RECOVERY SYSTEMS CO.
COMPTON, CALIFORNIA
Cable Address: VAREC COMPTON
Calif.,(U.S.A.) All Codes

961-2

For more information circle **160** on inquiry card.

ADVERTISERS' INDEX

A

Acragage Corp. 1504
Acromark Company 1456
Advance Electronics Co., Inc. 1454
Aero-Research Instrument Co. 1503
A'G'A Division of Elastic Stop Nut Corp. of America 1492
Airborne Instruments Laboratory, Incorporated 1397
Allegany Instrument Company 1452
Allied Radio Corp. 1496
American Electric Motors, Inc. 1420
American Electronic Mfg., Inc. 1410
American Machine & Metals, Inc. 1375
American Meter Company 1405
Amperite Co., Inc. 1435
Amthor Testing Instrument Co. 1452
Annin Company 1365
Atkomatic Valve Company 1450
Automatic Electric Mfg. Co. 1439
Automatic Temperature Control Co. 1357, 1491

B

Bacharach Industrial Instrument Co. 1497
Bailey Meter Co. 1376
Baldwin-Lima-Hamilton Corporation 1381
Barber-Colman Company 1418
Barber-Colman Company, Wheelco Instruments Division 1393
Bendix Aviation Corporation 1354, 1421
B-I-F Industries, Inc. 1454, 1490
Black, Sivalls & Bryson, Inc. Inside Front Cover
Bristol Company 1355, 1371, 1415
Brown Instruments Division of Minneapolis-Honeywell Regulator Co. 1430-1431
Brush Electronics Company 1389
Builders-Providence, Inc. 1454, 1490
Burgess Battery Company 1492

C

Cambridge Instrument Co., Inc. 1437
Chatillon & Sons, John 1403
Cinema Engineering Co. 1506
Clifton Precision Products Company, Inc. 1368
Commercial Research Laboratories, Inc. 1408
Consolidated Engineering Corp. 1441
Control Products, Inc. 1443
CONVAIR 1433
Copper & Brass Research Association 1390
Crescent Insulated Wire & Cable Co. 1384
Crucible Steel Company of America 1361

D

De Jur-Amsco Corporation 1449
Detectron Corporation 1505
Diamond Power Specialty Corp. 1498
Doelcam Corporation 1387
Dwyer Mfg. Co., F. W. 1491

E

Edmund Scientific Corp. 1493
Electric Switch Corp. 1490
Electro Products Laboratories, Inc. 1488
Electronic Associates Inc. 1448
Eppley Laboratory, Inc. 1350
Ernst Water Column & Gage Co. 1506
Esco Products Company 1450

F

Falstrom Company 1350
Fielden Instrument Division 1407
Fisher Governor Co. 1367
Foster Engineering Company 1456
Foxboro Company 1362-1363
Friez Instrument Div., Bendix 1421
Fulton Sylphon Division 1411

G

Gaertner Scientific Corp. 1442
General Electric Company 1352-1353
Genisco Incorporated 1451
Gertsch Products, Inc. 1491
G-M Laboratories, Inc. 1503
Goodyear Aircraft Corporation 1349
Gordon Co., Claud S. 1404
Green Instrument Co. 1490

H

Hagan Corporation 1388
Hammel-Dahl Company Back Cover
Haydon Company, A. W. 1457
Haydon Manufacturing Company, Inc. 1423
Hays Corporation 1391, Inside Back Cover
Heiland Research Corp. 1453
Heise Bourdon Tube Co. 1501
Hoke Incorporated 1489
Houston Technical Laboratories 1380

I

Illinois Testing Laboratories, Inc. 1436
Indiana Steel Products Company 1382
Industrol Corp. 1450
Instrof Incorporated 1455
Instrument & Control Consultants 1494
Instruments Publishing Co. 1419

J

Johnson Engineering Company Inc., Welton V. 1505

K

Kearfott Company, Inc. 1425
Kemp Mfg. Co., C. M. 1383
King Engineering Corporation 1452
Kirk & Blum Mfg. Co. 1372
Klipfel Valves, Inc. 1369
Kruger Instruments, Harold 1456
Kybernetes Corporation 1379

L

Lapp Insulator Co., Inc. 1495
Leeds & Northrup Co. 1398
Levin & Son, Inc., Louis 1497
Lewis Engineering Co. 1358
Librascope, Inc. 1377
Liquidometer Corp. 1503
Liston-Becker Instrument Company, Inc. 1505
Littleford Bros., Inc. 1424

M

Mallory & Co., Inc., P. R. 1394
Manning, Maxwell & Moore, Inc. 1356, 1396
Marsh Instrument Co. 1503
Marshalltown Mfg. Co. 1436
Martindale Electric Co. 1504
Measurements Corp. 1501
Meriam Instrument Co. 1445
Meyer-Opticraft, Inc. 1446
Minneapolis-Honeywell Regulator Co., Industrial Division 1430-1431
Moeller Instrument Co. 1485
Monsell, John R. 1458

N

Nash Engineering Company 1386
New Hermes Engraving Machine Corp. 1448
Niagara Blower Company 1447

O

Offner Electronics Inc. 1417
Ohmite Mfg. Co. 1487

P

Pacific Div., Bendix 1354
Palmer Thermometers, Inc. 1428
Panalarm Products, Inc. 1427
Parker Appliance Co. 1392
Permutit Company 1459
Philadelphia Thermometer Co. 1493
Preis Engraving Machine Co., H. P. 1458
Pritchard Company of California, J. F. 1409
Production Instrument Company 1489
Progressive Service Company 1493
Proportioneers, Inc. 1370

R

Rex Rheostat Co. 1506
Rodon, Inc. 1500
Rubicon Co. 1366

S

SCAM Corporation 1432
Scherr Co., Inc., George 1496
Shore Instrument & Mfg. Co. 1500
Smith Co., S. Morgan 1440
Sorensen & Co., Inc. 1438
Sprague Engineering and Sales Corp. 1488
Statham Laboratories 1406
Stevens-Arnold Inc. 1492
Stoddart Aircraft Radio Co., Inc. 1444
Struthers-Dunn, Inc. 1429
Swartwout Company 1374

T

Taylor & Co., W. A. 1426
Taylor Instrument Companies 1385
Technical Charts Incorporated 1457
Texas Instruments, Incorporated 1360
Trinity Equipment Corp. 1448

U

Uehling Instrument Co. 1454
Unertl Optical Co., John 1458
U. S. Electrical Motors Inc. 1499
United States Gauge, Div. of American Machine & Metals, Inc. 1375
United States Radium Corp. 1434

V

Vapor Recovery Systems Company 1507
Veeder-Root Inc. 1378
Viking Electric 1422

W

Wallace & Tiernan Incorporated 1373
Weatherhead Company 1395
Weckesser Company 1442
Welch Scientific Co., W. M. 1401
West Instrument Corporation 1459
Weston Electrical Instrument Corp. 1413
Wheelco Instruments Division, Barber-Colman Company 1393
Winzeler Manufacturing & Tool Co. 1437

Want to keep up-to-date on

AUTOMATION
AUTOMATIC CONTROL
INSTRUMENTATION

? ? ?

A 1-year subscription to

INSTRUMENTS and AUTOMATION

(for 28 years the world's leading magazine of measurement and control)

brings you:

more than 2,000 pages of instrumentation data.

The regular subscription price is $4.00, BUT:

On two or more new subscriptions or renewals sent together on one order the rates will be reduced as follows:

2 separate one-year subscriptions	$ 6.00
3 separate one-year subscriptions	7.50
4 separate one-year subscriptions	9.00
5 separate one-year subscriptions	10.00

Offer good only in U. S. and Canada

Use This Subscription Card ⏵

Inquiry Card ⏵

For further details concerning developments reported in advertisements, New Product or New Literature reviews, CIRCLE THE NUMBER corresponding to that which appears with the ad or write-up.

When indicating change of address, kindly note old address.

INSTRUMENTS PUBLISHING CO.
845 Ridge Avenue, Pittsburgh 12, Pa.

I am send $.....herewith, being payment in full for the subscriptions for INSTRUMENTS AND AUTOMATION listed below.

Signed .....

Address .....

Name ..... Position.....
Company .....
Products Manufactured .....
Address .....

Name ..... Position.....
Company .....
Products Manufactured .....
Address .....

Name ..... Position.....
Company .....
Products Manufactured .....
Address .....

Name ..... Position.....
Company .....
Products Manufactured .....
Address .....

Name ..... Position.....
Company .....
Products Manufactured .....
Address .....

For additional names use another sheet

please fill in COMPLETELY:

Name ..... Title .....

Company .....

Products Manufactured .....

Company Address ..... City ..... Zone..... State.....

☐ Check for address change. Show OLD address here:.....

Instruments and Automation Sept. '54
Good until 12-1-54

Advertised Products										New Instruments										New Literature									
1	21	41	61	81	101	121	141	161		201	221	241	261	281	301	321	341	361	381	401	421	501	521	541	561	581	601	621	641	661	
2	22	42	62	82	102	122	142	162		202	222	242	262	282	302	322	342	362	382	402	422	502	522	542	562	582	602	622	642	662	
3	23	43	63	83	103	123	143			203	223	243	263	283	303	323	343	363	383	403	423	503	523	543	563	583	603	623	643	663	
4	24	44	64	84	104	124	144			204	224	244	264	284	304	324	344	364	384	404	424	504	524	544	564	584	604	624	644	664	
5	25	45	65	85	105	125	145			205	225	245	265	285	305	325	345	365	385	405	425	505	525	545	565	585	605	625	645	665	
6	26	46	66	86	106	126	146			206	226	246	266	286	306	326	346	366	386	406	426	506	526	546	566	586	606	626	646		
7	27	47	67	87	107	127	147			207	227	247	267	287	307	327	347	367	387	407	427	507	527	547	567	587	607	627	647		
8	28	48	68	88	108	128	148			208	228	248	268	288	308	328	348	368	388	408	428	508	528	548	568	588	608	628	648		
9	29	49	69	89	109	129	149			209	229	249	269	289	309	329	349	369	389	409	429	509	529	549	569	589	609	629	649		
10	30	50	70	90	110	130	150			210	230	250	270	290	310	330	350	370	390	410	430	510	530	550	570	590	610	630	650		
11	31	51	71	91	111	131	151			211	231	251	271	291	311	331	351	371	391	411	431	511	531	551	571	591	611	631	651		
12	32	52	72	92	112	132	152			212	232	252	272	292	312	332	352	372	392	412	432	512	532	552	572	592	612	632	652		
13	33	53	73	93	113	133	153			213	233	253	273	293	313	333	353	373	393	413	433	513	533	553	573	593	613	633	653		
14	34	54	74	94	114	134	154			214	234	254	274	294	314	334	354	374	394	414		514	534	554	574	594	614	634	654		
15	35	55	75	95	115	135	155			215	235	255	275	295	315	335	355	375	395	415		515	535	555	575	595	615	635	655		
16	36	56	76	96	116	136	156			216	236	256	276	296	316	336	356	376	396	416		516	536	556	576	596	616	636	656		
17	37	57	77	97	117	137	157			217	237	257	277	297	317	337	357	377	397	417		517	537	557	577	597	617	637	657		
18	38	58	78	98	118	138	158			218	238	258	278	298	318	338	358	378	398	418		518	538	558	578	598	618	638	658		
19	39	59	79	99	119	139	159			219	239	259	279	299	319	339	359	379	399	419		519	539	559	579	599	619	639	659		
20	40	60	80	100	120	140	160			220	240	260	280	300	320	340	360	380	400	420		520	540	560	580	600	620	640	660		

Check square for "Computer Clinic" registration form. ☐
Check square for "Automation Exposition" registration card. ☐

Scheduled for Publication December 1954—

the revised and up-to-date Second Edition

Handbook of Measurement and Control

M. F. BEHAR, Editor

1. First Edition, published in 1952, filled a long recognized need for an instrumentation handbook.

2. This Second Edition further enhances the material covered . . . adds to it . . . notably with NEW chapters on Weighing, Time & Schedule, Electronic Instruments, Control Systems, and Servomechanisms. Up-dates ALL the material in the original handbook.

3. Each manufacturer is invited to describe in his own advertising or catalog pages the design, construction and specific advantages of his products.

4. Format . . . 7"x10" type page . . . is ideal for standard ¼, ½, and full-page sizes. Catalog-type ads are suggested as most applicable.

5. Published in even-numbered years, this Second Edition will appear as separately-bound Part II of the December 1954 issue of INSTRUMENTS & AUTOMATION.

6. Print order, 25,000; 20,000 to INSTRUMENTS & AUTOMATION subscribers.

FIRST CLASS
PERMIT No. 1441
(Sec. 34.9 P.L.&R.)
PITTSBURGH, PA.

BUSINESS REPLY CARD

NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

3c POSTAGE WILL BE PAID BY—

INSTRUMENTS PUBLISHING CO.
845 Ridge Avenue
Pittsburgh 12, Pa.

FIRST CLASS
PERMIT No. 1441
(Sec. 34.9 P.L.&R.)
PITTSBURGH, PA.

BUSINESS REPLY CARD

NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

3c POSTAGE WILL BE PAID BY—

INSTRUMENTS PUBLISHING CO.
845 Ridge Avenue
Pittsburgh 12, Pa.

Instrument Manufacturers

These special issues of INSTRUMENTS and AUTOMATION offer you extra reader coverage and interest:

- **NOVEMBER ISSUE—post-ISA-show issue contains special show-report, including highlights, features, and exhibits; this issue is always of extreme interest to the thousands of instrument men who could not attend the show.**
  ALSO—November will be the pre-Automation-SHOW issue listing exhibits and features of this important event.
- **DECEMBER ISSUE—Part 2 of this issue will be the separately-bound and revised 2nd edition of the HANDBOOK OF MEASUREMENT AND CONTROL. All subscribers will receive this.**
- **JANUARY (1955) ISSUE—will feature a complete report on THE FIRST INTERNATIONAL AUTOMATION EXPOSITION.**

INSTRUMENTS and AUTOMATION (the world's leading magazine of measurement and control) offers you these issues for your promotional advertising.

THE INSTRUMENTS PUBLISHING CO.
845 Ridge Ave., Pittsburgh 12, Pa., Fairfax 1-0161

a new miniature indicator!

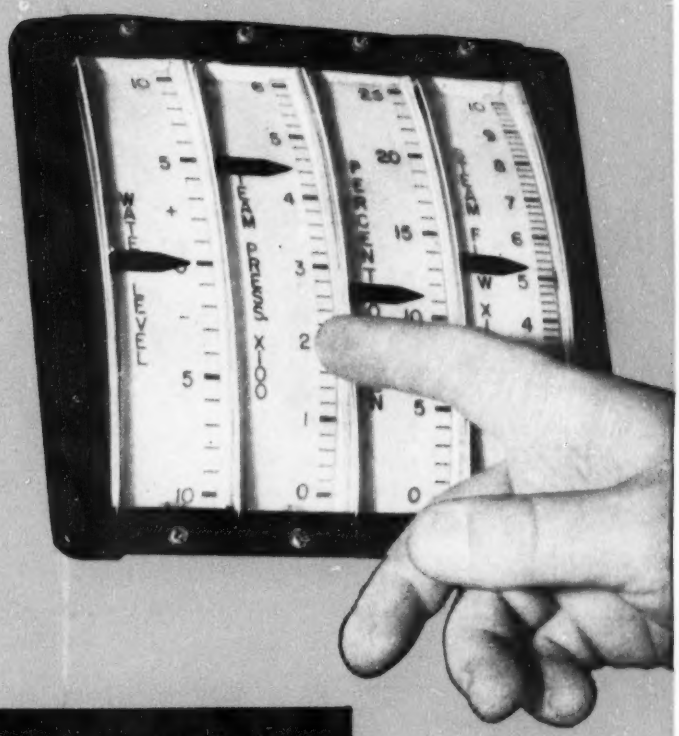
Available with:

MEASURED VARIABLE → AIR-PILOT → COPPER TUBING

PNEUMATIC TRANSMISSION

MEASURED VARIABLE → DIFF. TRANSF. → AMPLI-FIER

ELECTRICAL TRANSMISSION



removable units—interior illumination

easy to read—5 inch scale, no parallax

easy correlation of related functions

easy zero check from the front

HAYS Miniature Indicators

This miniature instrument is especially suited for remote indication of such variables as pressure, draft, flow or level.

The scale is only 5 inches long — easy to read — internally illuminated. Choice of pneumatic or electric transmission.

Also available is the Hays direct reading miniature gage for indicating *pressures* of fluids (steam, water, gas, oil, etc.) directly.

Gages are arranged for flush or semi-flush mounting. Either a yoke mounting, for as many as 12 units, or a keyhole clamp mounting for individual units can be provided.

Write today for full information on the Hays Miniature Indicator Bulletin 52-1075-223.

Automatic Combustion Control
Boiler Panels • Hays-Penn Flowmeters
Veriflow Meters and Veritrol
Gas Analyzers • Draft Gages
Combustion Test Sets • CO_2 Recorders
Electronic Oxygen Recorders
Electronic Flowmeters
Electronic Feed Water Controls
Miniature Remote Indicators

THE hays CORPORATION

MICHIGAN CITY 8, INDIANA

For more information circle **161** on inquiry card.

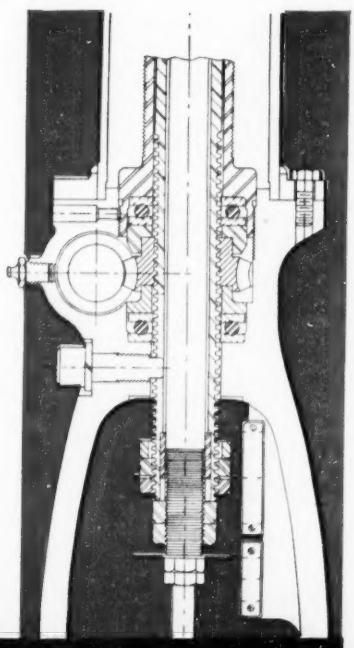
The Beauty of Functional Design

IN THE **HAMMEL-DAHL**

CONTINUOUSLY CONNECTED HANDWHEEL...

Achieved by integrating parts in the ***compact, completely enclosed*** gear housing illustrated below.

- STRAIGHT-LINE LIFT—No side thrust is exerted against the valve stem.
- COMPLETELY UNHAMPERED AUTOMATIC OPERATION—Permits limiting of valve lift if desired—but in the neutral position the handwheel mechanism offers *no resistance* to valve stem movement.
- INITIAL LUBRICATION LASTS INDEFINITELY.



COMPLETE Information in Bulletin 109-A

HAMMEL-DAHL COMPANY

175 POST ROAD, (WARWICK) PROVIDENCE 5, R. I., U. S. A.

SALES OFFICES IN ALL PRINCIPAL CITIES

MANUFACTURING PLANTS IN WARWICK, R. I., U. S. A., CANADA, ENGLAND, FRANCE AND HOLLAND

CANADIAN MANUFACTURING AFFILIATE—GUELPH ENGINEERING CO., GUELPH, ONT.

VISIT OUR BOOTH 410-412, FIRST INTERNATIONAL INSTRUMENT EXHIBIT—PHILADELPHIA, SEPTEMBER 13 THRU 24

For more information circle **162** on inquiry card.